Taxonomy, Life History, and Habits of the Elliptoid-eyed Species of *Schinia* (Lepidoptera: Noctuidae), with Notes on the Heliothidinae

by

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CONTENTS

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The subfamily Heliothidinae, consisting of about two hundred species, is of world-wide distribution, being particularly well represented in the arid and semi-arid regions of the globe. It is best represented in North America, especially in the southwestern portion of the continent, largely because of the great number of species of *Schinia* present there.

Initial studies of the Heliothidinae were undertaken to clarify the taxonomic status of forms inadequately described by some of the early workers. At present the valid application of many of these names, especially those of Strecker, is not possible. It soon became apparent, however, that the problem could not be solved merely by redescribing these little-known forms. Because geographic variation among heliothidine groups is often great, it is difficult to know whether forms differing geographically, constitute a complex of discrete species or races of a single highly variable species.

The foretibiae of many heliothidine moths have enlarged, curved spines, which in the literature have been termed claws; these claws are found sporadically within various noctuid groups. The frons varies somewhat in shape but is generally rounded centrally with a recurved ventral shelf or lip.

The male genitalia in the Heliothidinae are simple, the valve being generally elongate and straplike, usually with a row of setae, the corona, near its apical margin. A fingerlike process, the digitus, may or may not be present in the median area of the valve. The penis varies considerably, especially in the shape and armature of the eversible vesica. It may be unarmed as in *Schinia* or have a large number of cornuti as in *Heliothis armigera* (Hbn.). No subfamily characters were detected in the female genitalia.

At present the subfamily is poorly distinguished from the Noctuinae. In both subfamilies the eyes are hairless and unlashed and the mid and hind tibiae are spined. One of the most characteristic features of the Heliothidinae is the habit of the larvae of feeding on the flowers and fruit of their food plants. The moths commonly frequent the blossoms of the plants on which the larvae feed.

As the Heliothidinae are presently conceived, several genera whose affinities, in my opinion, apparently lie with the subfamily are excluded from it. *Eutricopis* Morr. and *Pyrrhia* Hbn. are at present lumped in the Amphipyrinae because of the absence of spines on the tibiae. However, other adult and larval features, and the habit of feeding as larvae on the blossoms and fruit of their food plants, suggest their heliothidine relationships.

On the other hand, the *Grotella* group, which is now included in the Heliothidinae because of the presence of claws on the foretibia and spines on the mid and hind tibiae, otherwise show no very close relationship with other members of the subfamily. The group shows greater affinity in several ways with the Acontiinae.

The majority of North American heliothidine moths are referable to the

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genus *Schinia*. This paper is a report on a study of the elliptoid-eyed group of the genus, which consists in large part of those species formerly referred to *Melicleptria*. In my opinion, the elliptoid-eyed species do not represent a monophyletic group within the genus. The majority of them have probably been derived from a single stem, but a number of the more atypical forms are probably not so closely related to the core of the present group as are many of the globular-eyed, nocturnal species. The elliptoid-eyed species of *Schinia* do not comprise a large segment of the Heliothidinae or of the genus to which they belong. Nineteen species, including *Melicleptria graefiana* Tepper, the identity of which could not be determined, are considered in the analysis.

In this paper, the species concept adopted is perhaps relatively broad. Allopatric populations, essentially identical except for some difference in maculation, or for a slight difference in structure, are considered as representing a single, variable species. This interpretation is adopted with more confidence in those cases in which the food plants belong to the same genus. The employment of experimental taxonomy may ultimately help to solve the statuses of these populations.

In addition to morphological descriptions of the adults, this paper includes an analysis of the structure of eggs, larvae, and pupae in all cases in which material was available for study. Information on life history and habits is also included for those species that were studied in the field and whose larvae were reared.

The estimate of variation following the mean of measurements listed in the text is the standard deviation of the sample considered. When such measurements are of larval or pupal structures, or of the duration of stadia, neither the means nor the standard deviations can be presumed to represent those of the populations from which the reared material was obtained. Because of the progeny of only a few females were usually reared, the sample cannot be considered representative. Because adults that emerge from captive pupae were often somewhat dwarfed, means of measurements of larval and pupal structures may be low. Finally, because the development of cultured larvae was in some cases more advanced than that of corresponding larvae in the field, values for durations of instars may also be low.

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HISTORICAL REVIEW OF THE HELIOTHIDINAE

Apart from its inclusion in Hübner's invalidated *Tentamen Lepidopterorum* of 1806, the first usage of *Heliothis* was in Hübner's *Erste Zuträge zur Sammlung exotischer Schmetterlinge* of 1808. Before Hemming's monumental publication on Hübner in 1937, the *Erste Zuträge* had been largely overlooked or ignored by workers on Lepidoptera. According to Hemming's interpretation, however, the names in this list became valid when the accompanying plates were released. In the *Erste Zuträge*, Hübner included only *jucunda* in the genus *Heliothis* and these two names would become valid when the fifteenth plate was released between 1809 and 1813. *Jucunda* was subsequently listed in the *Zuträge zur Sammlung exotischer Schmetterlinge*, published in 1818, as the only species included in the genus *Melipotis*. If the *Erste Zuträge* names are deemed valid, then *Heliothis* must become a catocaline genus and *Melipotis* a primary synonym of it. Such a procedure could lead only to nomenclatorial confusion because *Heliothis* has not subsequently been associated with *jucunda* and has become the type genus of another subfamily.

If the *Erste Zuträge* names are not accepted the first valid usage of *Heliothis* was evidently that of Ochsenheimer (1816) and the first type species selection for the genus that of *dipsacea* (L.), by Samouelle (1819).

A similar tangle would result from accepting the name *Euclidia* Hübner as of the *Erste Zuträge*. The species illustrated in the *Zuträge* as *Schinia gracilenta* in 1818 was previously listed in the *Erste Zuträge* as *Euclidia gracilis*. Five species, *gracilis*, *graphica*, *trifascia*, *bifascia* and *cuspidea* were included in *Euclidia* in the *Erste Zuträge*. Only *gracilis*, however, was described in that publication and as pointed out by Tams (1939), would become type species of

Euclidia. *Schinia*, in this event, would become a synonym of *Euclidia*, at present also considered a catocaline genus.

The *Erste Zuträge* names are ignored in this paper because their acceptance would result in concepts entirely foreign to current usage.

Apparently the first worker on Lepidoptera to consider species of *Heliothis* and their allies or supposed allies as a group on anything above the generic level was Boisduval (1829). He included the genera *Anarta*, *Heliothis*, and *Acontia* in the tribe Heliothidi.

In 1840, Boisduval somewhat altered his previous arrangement by removing *Acontia* and using this genus as the basis of a new tribe of the Heterocera. In this work he described the heliothidines as brightly coloured day-flying moths whose larvae feed on low-growing plants.

Guenée (1841) considered the group a tribe of the Noctuidae and added one or two genera. In a subsequent treatise in 1852, he listed over a dozen genera not included by Boisduval and elevated the assemblage to subfamily rank.

In 1844, Duponchel gave the group tribal status as the Heliothides and included only *Heliothis*, *Anthoecia*, and *Anarta*.

The first comprehensive work on the North American species was that of Smith (1882), who considered them to constitute a subfamily of the Noctuidae. His arrangement and conclusions were in considerable part based on pioneer work done by Gróte on the Nearctic Noctuidae. In his revisionary work, Smith ignored the structure of the male genitalia because he considered they could "never have a generic significance".

While disagreeing with certain of Smith's generic usages, Grote (1883) largely accepted Smith's arrangement.

Hampson (1903), in his monograph on the Noctuidae of the world, included most of the heliothidine genera in his subfamily Agrotinae because of the presence of spines on the tibiae. He thus excluded from the group those genera with unspined tibiae included in the Heliothidinae by Grote and Smith.

Warren (1911), in monographing the Palaearctic Noctuidae, went to the other extreme and separated the natural components of the group into two subfamilies, the Melicleptriinae and the Heliothidinae. The latter subfamily is a particularly hetergeneous assemblage comprising elements representing many noctuid groups.

Draudt (1927), in monographing the Nearctic Noctuidae, presented the subfamily essentially in its presently accepted arrangement. He included a few genera, however, that are not now considered as natural components of the Heliothidinae.

McDunnough (1928) supported Warren and Draudt in excluding the heliothidine genera from the Agrotinae in his generic revision of the latter group. In his 1938 check list, McDunnough followed Draudt and earlier workers in relegating the Heliothidinae to a position in the Noctuidae remote from the Noctuinae (= Agrotinae).

In his recent work on the Noctuidae, Forbes (1954) again grouped the heliothidinae moths with the Agrotinae (= Noctuinae = Phalaeninae), as a tribe.

In my opinion the Heliothidinae are a sufficiently discrete group on the basis of life history and habits alone to warrant their treatment as a subfamily of the Noctuidae. The similarity of structure of the heliothidines and noctuines, however, suggests a more intimate relationship than is indicated by their placement in McDunnough's 1938 list.

REARING TECHNIQUES

To obtain life history information and material representing immature stages for preservation and subsequent study, female moths captured in the field were confined with buds and blossoms of the food plant to induce oviposition. Mating pairs were especially prized in the hope that the females would subsequently deposit full complements of eggs. A single female was placed in each oviposition jar, and in case the females were unmated, one or two males were confined with each.

The oviposition containers were one-gallon battery, pickle, or candy jars with wire- or cloth-mesh tops to permit free ventilation. A small jar or large vial containing a few sprigs of buds and blossoms of the food plant in water was secured within each of the large jars. Often a few blossoms of other plants were included with those of the food plant to provide a source of nectar for the confined moths. The mouth of the jar or vial containing the buds of the food plant were stoppered with cotton wool to prevent the moths from falling into the water. To provide an additional source of food, the plants in the oviposition jar were sprayed frequently with a weak solution of sugar in water.

This oviposition jar was eminently satisfactory in obtaining eggs from most species of Heliothidinae that were taken in the field. For those species whose larvae are of restricted feeding habits, the correct food plant must be offered to induce oviposition. Moreover, the food plant must be in suitable condition of development and freshness and the oviposition container must be suitably large if good results are to be obtained. The moths copulate and oviposit freely in these jars.

The glass-topped tins or jelly jars that are suitable oviposition containers for many noctuids, especially the true cutworms, proved useless for those heliothidine species confined in them.

The food-plant blossoms in the oviposition containers were replaced daily and the removed blossoms dissected for eggs. These were counted and stored in small vials until hatching time. They were examined periodically to determine any visible developmental changes.

Initially, larvae were reared en masse as well as individually. Mortality was so high and size often so diminutive with the former method, however, that it was soon discontinued. Mass rearing was unsatisfactory not only because of cannibalism, which is excessively strong, especially in the early stadia of many of the species reared, but also because of the inability of many of the young larvae to find the nourishing portions of the heads of the food plants on which they normally feed. Most first-stadium larvae of *Schinia separata* (Grt.), for example, seem incapable of penetrating the heavy sepals of the buds of *Artemisia tridentata* Nutt. In nature the larva hatches near the centre of the bud and can commence to feed at once on the more tender developing florets and seeds. In rearing such species it was necessary to pry open the bud or blossom with forceps and insert the young larva.

Individually reared larvae were confined for the first two or three stadia in numbered shell vials (1 x ⅜ inch) stoppered with wads of cotton wool. If the food-plant material dehydrated too rapidly, the cotton plug was moistened appropriately.

Reared larvae were examined every second day, changes in stadium were noted, cast head capsules were removed and preserved, old food material was discarded, the vials were cleaned, and fresh food was added. This periodic check indicated the number of stadia and allowed estimates of their durations.

Colour patterns were described during the rearing and specimens representing each stadium were preserved for subsequent study.

During the intermediate stadia, the individual larvae were removed to larger vials (4 x 1 inch). When the larvae moulted into the ultimate stadium about an inch of sandy soil was placed in the bottom of each rearing vial for pupation.

When the larvae retired into the soil all food material was removed from the vials, and after pupation the insects were removed from their individual containers and the sex of each determined.

BEHAVIOUR AND DEVELOPMENT OF THE HELIOTHIDINAE

The reduced, elliptoid eyes of a heliothidine or of any other noctuid moth is usually a reliable indication of its diurnal habits. The reverse, however, is not necessarily true. Those species with full, globular eyes are not exclusively nocturnal.

Schinia gaurae (J. E. Smith) and *Schinia pallicincta* (Sm.) are examples of nominally nocturnal species that have been noted flying actively and ovipositing during the day. Probably many species in the family exhibit similar adaptability. *Heliothis ononis* (Schiff.), in which the eyes are only somewhat reduced, is predominantly a day-flier.

Those nocturnal species that were studied in the field become active at dusk. They are readily attracted by light but are not, in my experience, attracted to sugaring bait.

The diurnal species of the subfamily show marked similarity in behaviour. Adults of those species that were reared emerge from the pupae in the early morning. Moths in captivity and those observed in the field became active in the late morning. The little insects are generally very rapid fliers, moving from blossom to blossom and alighting periodically to feed or oviposit. Those species inhabiting areas subject to high daytime temperatures may exhibit behaviour contrary to this general pattern. On a hot day during the first of April in the open desert east of the Fish Creek Mountains of Imperial County, California, *Schinia dobla* (Sm.) became inactive at noon and remained hidden for the remainder of the day among the foliage of its food plant. Moths were seen feeding and ovipositing at midmorning but it is not known at what time of the day the colony became active.

Varying degrees of protective colouration are exhibited by many species of the subfamily. The degree of protection afforded by the resemblance of a moth to the flowering head of its food plant is, of course, difficult to assess, but the beautiful blending of colour and markings of the wings with those of the flowering head on which the moth is resting is, in many species, remarkable. The purple and yellow of the forewings of *Schinia pulchripennis* (Grt.), for example, as the moth nestles in the head of *Orthocarpus purpurascens* Benth., makes the insect, at least to the human eye, difficult to detect.

The resting habits of adults of *Schinia florida* (Gn.) are most interesting. The proximal three-quarters of the forewing of this species are pink and the remainder is yellow. The insect, which feeds in the larval stage, on the pods of the evening primrose, *Oenothera biennis* L., usually rests during the daytime in the closed trumpetlike corolla of the food plant. Commonly only the distal yellow marginal band of the forewing protrudes from the corolla and this matches the colour of the yellow blossom so well that the moth is easily overlooked. Often, however, the moth may be seen merely resting among the

blossoms on the head of the food plant. Even then, it is not readily detected because the pink of its wings closely resembles the colour of a dried corolla tube that has not yet dropped to the ground.

The little day-flying heliothidine, *Heliosea pictipennis* Grt., may often be found sitting in the head of its food plant, *Malacothrix californica* DC. The red "button" at the centre of the blossom forms a background with which the pink or red of the forewing of the moth readily blends. In the late afternoon the blossom of *Malacothrix* sp. closes, partially or completely concealing the moth that has settled in the blossom. The insect is thus afforded a shelter similar to that sought by *Schinia florida* in the corolla of *O. biennis*.

Among the day-flying species that were studied, those that show the highest degree of protective colouration have the most sedentary habits. *Schinia indiana* (Sm.), which closely resembles the blossom of *Phlox pilosa* L., is seldom observed flying, but may be found at almost any period of the day resting on the blossom of the food plant.

A striking exception to the resemblance of the more brightly coloured species to the blossoms of their food plants is found in *Heliolonche carolus* McD. The forewing of the adult of this species is bright mauve or purple marked with yellow and the hind wing is brillant orange. The moths resting or copulating on the white blossoms of the food plant, *Rafinesquia neomexicana* Gray, are readily detected even from some distance.

Members of the subfamily vary greatly in the complexity of oviposition patterns. A female of *Dysocnemis oregonica* (Hy. Edw.) ovipositing on *Geranium* spp. scatters its eggs more or less at random over the surface of the buds. The adult of *Schinia pulchripennis* (Grt.) usually conceals its eggs among the blossoms and bracts of the head of *Orthocarpus purpurascens*.

Females of those species that oviposit on open composites, such as *Eutricopis nexilis* Morr. on *Antennaria* spp., alight on the blossom and insert the eggs between the individual florets of the head. The eggs are commonly placed between the pappus and corolla near the base of the floret. *Heliolonche carolus* McD. deposits its pearl-like eggs among the seeds in the elongate head of *Rafinesquia neomexicana*. So great is the effort on the part of the female to traverse the florets and reach the developing seeds that the moth burrows backward into the blossom. The whole abdomen and often a portion of the thorax is thrust downward among the florets so that the crumpled wings of the moth may be seen projecting vertically above the surface of the blossom.

Schinia separata (Grt.) has the most elaborate oviposition pattern of the species studied. Flying to a clump of its food plant, *Artemisia tridentata* Nutt., the female alights on a spray of the still tightly closed buds and crawls over it, her abdomen arching ventrally. Having arrived at a site that is apparently suitable, she secures herself by grasping buds and stems firmly with clawed tarsi, and begins an elaborate exploration with the ovipositor. The abdomen is arched ventrally and anteriorly, often being thrust forward so as to protrude between the legs. The ovipositor, on encountering the small hard bud, feels the surface and probes it with short, delicate stabbing movements. When the edge of one of the stiff outer sepals of the bud is encountered the blades of the knifelike ovipositor are forced against this edge and the moth, by rapid lateral movements of the abdomen which cause her whole body to vibrate, inserts the ovipositor valves beneath the sepal. In this manner the egg is deposited within the bud at or between the bases of the innermost sepals. The ovipositor is then withdrawn and the moth usually flies to another bud

cluster before the process is repeated. In being wedged between florets or beneath sepals, the eggs are often so greatly distorted as to cause one to wonder how embryonic development can proceed unimpaired. It is not uncommon for an egg, which will subsequently produce a normal, healthy larva, to be pressed into the shape of a rather thick pancake or of an angular wedge.

The number of eggs laid by different species of the Heliothidinae varies greatly. Quaintance and Brues (1905) recorded individual females of *Heliothis zea* (Boddie) laying up to 3000 eggs. Captive females of *Eutricopis nexilis* Morr., on the other hand, did not lay more than ten eggs; in view of the diminutive size of this species and its excessively large egg, the number that it is capable of laying probably does not greatly exceed this total.

Among the elliptoid-eyed species that were reared, females of *Schinia sueta* (Grt.) laid the greatest number of eggs, the maximum number per female being 356. The species that laid the fewest eggs was *Schinia scarletina* (Sm.), the greatest number per female being 15.

The eggs of species of Heliothidinae that were reared, including those considered in this paper, have an incubation period of three days to one week at room temperature, the eggs most commonly hatching in five or six days. The incubation period is evidently very strongly influenced by temperature. Eggs laid by several females of *Schinia villosa subatra* (Sm.) at 6000 feet in Manning Park, B.C., and kept for seven days in that habitat before removal to Oliver, at an elevation of 1000 ft. in the interior of British Columbia, required ten days after deposition to hatch. Eggs laid by other females of the same subspecies on the same day at the lower altitude hatched after only four days.

Of the species of Heliothidinae that I have reared, the eggs are yellow or pale yellow-green when deposited. These eggs may or may not change colour during incubation. The eggs of *Schinia villosa* (Grt.) and of *S. dobla* (Sm.) show no colour change until the day before hatching, when the ocelli become evident as two dark patches. Then a few hours before hatching the whole head and subsequently the prothoracic shield darken and become visible through the chorion. In *Schinia walsinghami* (Hy. Edw.), usually little colour change is evident during development because the pale head capsule and prothoracic shield of the first instar larva are often not readily visible through the chorion. On the day after deposition, the eggs of *Heliothis phloxiphaga* G. & R. and *Schinia florida* (Gn.) develop a girdling band of red anterior to the equator. In *Schinia indiana* (Sm.) the anterior half of the egg becomes progressively dark yellow, orange, orange-brown, and dark brown during incubation.

At hatching time, the larva is folded in the shape of a U within the eggshell with the head and caudal end tightly compressed at the micropylar end. The imminence of hatching is first evident by movements of the larval head. The initial break in the chorion is effected by the larva biting at the inside wall of the shell with its mandibles. This process may continue for several minutes until the larva at last pinches and bites through a small fold of the chorion. By persistent tearing and biting the initial puncture is enlarged until the head can be partially protruded so that the larva can more efficiently chew the edge of the torn shell.

The larva of *Schinia citrinella* (G. & R.) rests for many minutes within the shell after it has made an exit hole in the relatively tough chorion characteristic of that species. In other species observed the resting period is not so protracted.

The larva leaves the shell head-first. By slow undulating movements, not

infrequently interrupted by rest periods, the U is gradually straightened and the newly born caterpillar is free. In the species studied the newly hatched larva did not consume the remainder of the chorion.

The first-stadium larva is generally white, cream, or grey with black or dark-brown head capsule and prothoracic shield. The second-stadium larva differs little except for a somewhat paler head capsule and prothoracic shield. Definitive maculation and colouring are usually suggested in the third stadium, but both maculation and colouring become progressively more complex in successive stadia.

The newly hatched larva feeds within the blossom in which the egg was deposited, some species eating portions of the flower. The larva of *Schinia sueta* (Grt.) commonly feeds on the anthers before attacking the pod. Other species may move directly to, and feed on, the developing seeds.

Intermediate instars of several of the species studied burrow into the seed pod or capsule and seal their entrance holes with silk. On gaining entrance, the larva feeds on the seeds and fleshy inner tissues of the pod. While the larva is confined, the husk of the seed pod or capsule often dries and becomes hard and tough. Under these conditions the larva was not seen to release itself, and perhaps could not do so until the seed pod or capsule dehisced. This confinement until dehiscence was noted commonly among reared larvae of both *Schinia sueta* (Grt.) and *Schinia indiana* (Sm.).

The habits of later-stadium larvae vary from species to species. Those species that resemble the heads of their food plants in colouring remain on the heads during the daytime. The purplish-brown and yellow of the later-stadium larvae of *Schinia pulchripennis* (Grt.) blend well with the colour of the heads of *Orthocarpus purpurascens* on which they feed. Larvae of this species in any stadium may be found on the heads. Last-stadium larvae of *Schinia sueta* (Grt.) and of *S. villosa* (Grt.), on the other hand, were not found on their food plants. Presumably they hide during the daytime in the débris at the bases of the plants.

Development is continuous in the larval stage and no diapause was noted in any of the species reared.

The species studied vary considerably in the number of larval stadia. Both sexes of *Heliothis phloxiphaga* G. & R. and *Dysocnemis oregonica* (Hy. Edw.) complete their development in five or six stadia, the occasional individual of at least the latter species requiring seven stadia. The larva of *Eutricopis nexilis* Morr. completes its development in only four stadia. The elliptoid-eyed species of *Schinia* usually attain their full growth in five larval stadia. One individual in about 50 reared of each of *Schinia scarletina* (Sm.) and the interior of British Columbia subspecies of *Schinia villosa* (Grt.) matured in six stadia. Each stadium was commonly of several days' duration, the first and last usually being somewhat longer than the others.

The full-grown larva burrows into the ground to pupate. It is not known how deep the larvae of various species burrow but presumably it is at least several inches. In most species, the larva forms a pupal cell merely by pushing back the soil. The larva of *Eutricopis nexilis* Morr., however, fashions an elongate cocoon of silk into which it incorporates particles of soil and other foreign material; the upper end of the cocoon rests at or near the surface of the ground.

Emergence from the pupa was observed in a number of captive individuals of two species, *Schinia felicitata* (Sm.) and *Schinia niveicosta* (Sm.). In these

species the moth emerged from the pupal case within the pupal cell and made its way to the surface through the tunnel previously formed by the larva. The larva thus facilitated the escape of the adult by making, through the hard-packed soil, an exit tube filled with loose dirt.

Reared larvae of *Schinia pallicincta* (Sm.) that were allowed to pupate in very dry sand spun a fragile tunnel of silk down to the pupal cell. When the sand between the pupal cell and the surface of the soil was examined an elongate string of silk with adhering particles of sand could be removed. When specimens of this species pupated in moist soil, however, no evidence of this silken tunnel was found. Whether the spun tube is actually absent, or merely undiscernible in moistened soil that has subsequently hardened, is not known.

Several species of Heliothidinae have two or more annual broods. In North America, *Heliothis zea* (Boddie) has several generations a season in the more southerly portion of its range. Similarly, *Heliothis phloxiphaga* G. & R. probably produces successive generations as long as the season remains suitable. In western North America, moths of this species may be collected in any of the spring or summer months. In southern California, *Schinia niveicosta* (Sm.) evidently has at least a partial fall generation as well as a spring generation if sufficient rainfall is received to cause a fall-blooming of its food plant, *Palafoxia linearis* L.

In reared material it is not unusual to have moths emerge only a fortnight or so after pupation. A large percentage of reared individuals of *Schinia felicitata* (Sm.), *niveicosta* (Sm.), and *scarletina* (Sm.) followed this pattern. In the arid areas in which the food plants of these species occur, probably only the progeny of the earliest-flying individuals would produce a second generation that could complete its larval development.

The dates of capture of museum specimens indicate that *Schinia sueta* (Grt.) is single-brooded throughout its range. A small number of adults of the northwestern subspecies of this species, however, emerged in the late summer from pupae reared from eggs deposited earlier the same season. Adults of this subspecies were not collected so late in the field. Certainly the food plant, *Lupinus* sp., had completed its seasonal development in the locality in which the insects were reared and had disappeared at the time of emergence of these individuals. Similarly a small percentage of reared individuals of *Dysocnemis oregonica* (Hy. Edw.) and *Schinia florida* (Gn.) emerged in the late summer.

The abbreviated pupal period in these species may be due entirely to the artificial conditions of rearing. In desert-dwelling species even a slight increase in soil moisture may be sufficient to initiate pupal development and subsequent emergence. Under natural conditions, however, all species apparently emerge only when their food plants are in bloom. Generally, if the blossoming period of the food plant is protracted, the period of flight of its dependent species is also protracted.

Species of Heliothidinae vary greatly in range of food plants. *Heliothis zea* (Boddie) feeds on a wide variety of plants, including corn, cotton, tomato, and peas. *Heliothis phloxiphaga* G. & R. also has a wide range of food plants. The food plants of many other species, however, seem to be rigidly determined. Reared larvae of *Schinia dobla* (Sm.), which normally feed on *Franseria dumosa* Gray, would not accept the flowers and fruit of a large number of other plants, including several composites. These larvae finally died when *F. dumosa* was no longer available.

GENUS *SCHINIA* HÜBNER

Type: *Schinia trifascia* Hbn.
1818. Hübner, Zutr. zur Sammlung ex. Schmett. 1: 8, 11, 14; *gracilenta, trifascia* and *bifascia* included.
1874. Grote, Bull. Buff. Soc. Nat. Sci. 2: 32; *trifascia* cited as type.
1882-83. Smith, Trans. Am. Ent. Soc. 10: 207 (1882), 225 (1883).
1883. Grote, Proc. Am. Phil. Soc. 21: 173.
1893. Smith, Bull. U.S. Nat. Mus. 44: 274.
1895. Grote, Check list, p. 67; *gracilenta* cited as type.
1903. Hampson, Cat. Lep. Phal. 4: 72.
1927. Draudt, Groszschmett. der Erde 7: 339.
1939. Tams, Entomologist 72: 138; should be replaced by *Euclidia.*
1954. Forbes, Lep. New York, part 3, p. 20.

Melicleptria Hübner (new synonymy); type: *Noctua cardui* Hbn.
(1823) Hübner, Verz. bek. Schmett., p. 262; *scutosa, peltigera, alphea, dipsacea, ononis,* and *cardui* included.
1873. Grote, Bull. Buff. Soc. Nat. Sci. 1: 116; considered a subgenus of *Heliothis; cardui* cited as type.
1874. Grote, Bull. Buff. Soc. Nat. Sci. 2: 34; raised to generic rank.
1882-83. Smith, Trans. Am. Ent. Soc. 10: 206, 207 (1882), 243 (1883).
1903. Hampson, Cat. Lep. Phal. 4: 97; *scutosa* cited as type.
1911. Warren, Groszschmett. der Erde 3: 248.
1916. McDunnough, Ent. News 27: 394; *cardui* cited as type replacing *Heliothis* as used by Hampson.
1927. Draudt, Groszschmett. de Erde 7: 331.
1939. Tams, Entomologist 72: 137.

Anthoecia Boisduval; type: *Noctua cardui* Hbn.
1840. Boisduval, Gen. et Index Meth., p. 162; *cognata* and *cardui* included.
1852. Guenée, Hist. Nat. Ins., Noct. 2: 183; *cardui* cited as type.
1890. Grote, Revised check list, p. 36; sunk to *Melicleptria.*
1891. Smith, Check list, p. 54; sunk to *Schinia.*
1903. Hampson, Cat. Lep. Phal. 4: 15; *cognata* cited as type; sunk to *Heliothis.*
1916. McDunnough, Ent. News 27: 394; sunk to *Melicleptria.*

Alaria Duncan (nec Schrank, 1788; new synonymy); type: *Phalaena gaurae* J. E. Smith.
1841. Duncan, Jardines Nat. Lib. 33: 200; only *gaurae* included.
1882. Smith, Trans. Am. Ent. Soc. 10: 223.
1893. Smith, Bull. U.S. Nat. Mus. 44: 272.
1902. Dyar, Bull. U.S. Nat. Mus. 52: 186; sunk to *Rhodophora.*

Trypana Guenée (new synonymy); type: *Noctua cardui* Hbn.
1841. Guenée, Ann. Soc. Ent. France 10: 58; *cardui* and *cognata* included.
1852. Guenée, Hist. Nat. Ins., Noct. 2: 183; sunk to *Anthoecia* Bdv.
1903. Hampson, Cat. Lep. Phal. 4: 15; *cardui* cited as type; sunk to *Heliothis.*

Rhodophora Guenée (new synonymy); type: *Rhodophora florida* Gn.
1852. Guenée, Hist. Nat. Ins., Noct. 2: 170; *gaurae* and *florida* included.
1874. Grote, Bull. Buff. Soc. Nat. Sci. 2: 33; *florida* cited as type.
1882. Smith, Trans. Am. Ent. Soc. 10: 223; sunk to *Alaria.*
1883. Grote, Proc. Am. Phil. Soc. 21: 175.
1903. Hampson, Cat. Lep. Phal. 4: 55; *gaurae* cited as type.
1927. Draudt, Groszschmett. der Erde 7: 335.
1954. Forbes, Lep. New York, part 3, p. 26.

Tamila Guenée; type: *Noctua nundina* Drury.
1852. Guenée, Hist. Nat. Ins., Noct. 2: 176; only *nundina* included.
1873. Grote, Bull. Buff. Soc. Nat. Sci. 1: 121; considered a subgenus of *Heliothis.*
1874. Grote, Bull. Buff. Soc. Nat. Sci. 2: 35; raised to generic rank.
1875. Grote, Bull. Buff. Soc. Nat. Sci. 2: 219.
1883. Smith, Trans. Am. Ent. Soc. 10: 225; sunk to *Schinia.*

Oria Guenée (nec Hübner, 1821); type: *Oria sanguinea* Geyer.
1852. Guenée, Hist. Nat. Ins., Noct. 2: 166; only *sanguinea* included.
1874. Grote, Bull. Buff. Soc. Nat. Sci. 2: 33.

Euleucyptera Grote; type: *Euleucyptera cumatilis* Grt.
1865. Grote, Proc. Ent. Soc. Philadelphia 4: 329; only *cumatilis* included.
1883. Smith, Trans. Am. Ent. Soc. 10: 225; sunk to *Schinia.*

Lygranthoecia Grote & Robinson; type: *Crambus marginatus* Haw.
1873. Grote and Robinson, Trans. Am. Ent. Soc. 4: 432; *marginatus* and *thoreaui* included.
1873. Grote, Bull. Buff. Soc. Nat. Sci. 1: 115.
1874. Grote, Bull. Buff. Soc. Nat. Sci. 2: 33; *marginatus* cited as type.
1883. Smith, Trans. Am. Ent. Soc. 10: 225; sunk to *Schinia.*
1883. Grote, Trans. Am. Ent. Soc. 10: 262; considered a distinct genus.
1883. Grote, Proc. Am. Phil. Soc. 21: 173; *rivulosa* cited as type.
1895. Grote, Check list, p. 67; sunk to *Schinia.*
1903. Hampson, Cat. Lep. Phal. 4: 60; considered a distinct genus.
1927. Draudt, Groszschmett. der Erde 7: 337.
1954. Forbes, Lep. New York, part 3, p. 20; sunk to *Schinia.*

Tricopis Grote; type: *Tricopis chrysellus* Grt.
1874. Grote, Bull. Buff. Soc. Nat. Sci. 2: 75; only *chrysellus* included.
1883. Smith, Trans. Am. Ent. Soc. 10: 225; sunk to *Schinia.*
1883. Grote, Trans. Am. Ent. Soc. 10: 263; considered a distinct genus.
1903. Hampson, Cat. Lep. Phal. 4: 72; sunk to *Schinia.*

Adonisea Grote (new synonymy); type: *Melicleptria pulchripennis* Grt.
1875. Grote, Bull. Buff. Soc. Nat. Sci. 2: 220; only *pulchripennis* included.
1883. Smith, Trans. Am. Ent. Soc. 10: 243; sunk to *Melicleptria.*
1903. Hampson, Cat. Lep. Phal. 4: 15; sunk to *Heliothis.*

Heliophana Grote (new synonymy); type: *Heliothis mitis* Grt.
1875. Grote, Bull. Buff. Soc. Nat. Sci. 2: 220; only *mitis* included.
1883. Smith, Trans. Am. Ent. Soc. 10: 240.
1903. Hampson, Cat. Lep. Phal. 4: 13.
1927. Draudt, Groszschmett. der Erde 7: 331.

Oxylos Grote (new synonymy); type: *Heliothis citrinellus* G. & R.
1875. Grote, Check list, p. 35; only *citrinellus* included.
1882. Grote, Can. Ent. 14: 172; sunk to *Heliothis.*
1882. Smith, Trans. Am. Ent. Soc. 10: 223; sunk to *Alaria.*
1902. Dyar, Bull. U.S. Nat. Mus. 52: 186; sunk to *Rhodophora.*
1903. Hampson, Cat. Lep. Phal. 4: 49; considered a distinct genus.
1927. Draudt, Groszschmett. der Erde 7: 335.

Pippona Harvey; type: *Pippona bimatris* Harv.
1875. Harvey, Bull. Buff. Soc. Nat. Sci. 3: 9; only *bimatris* included.
1882. Smith, Trans. Am. Ent. Soc. 10: 216.
1903. Hampson, Cat. Lep. Phal. 4: 60; sunk to *Lygranthoecia.*
1938. McDunnough, Check list, part 1, p. 105; considered a distinct genus.
1954. Forbes, Lep. New York, part 3, p. 20; sunk to *Schinia.*

Rhodopipsa Grote[3] (new synonymy); type: *Alaria volupia* Fitch.
1877. Uhler, Bull. U.S. Geol. Surv. 3: 769.
1877. Grote, Bull. U.S. Geol. Surv. 3: 797; only *volupia* included.
1883. Smith, Trans. Am. Ent. Soc. 10: 250.
1883. Grote, Proc. Am. Phil. Soc. 21: 174.
1903. Hampson, Cat. Lep. Phal. 4: 59.
1927. Draudt, Groszschmett. der Erde 7: 336.
1954. Forbes, Lep. New York, part 3, p. 25.

Porrima Grote[3]; type: *Oria sanguinea* Geyer.
1877. Uhler, Bull. U.S. Geol. Surv. 3: 769.
1877. Grote, Bull. U.S. Geol. Surv. 3: 798; only *sanguinea* included.
1893. Smith, Bull. U.S. Nat. Mus. 44: 274; sunk to *Schinia.*

Bessula Grote; type: *Bessula luxa* Grt.
1881. Grote, Papilio 1: 176; only *luxa* included.
1882. Smith, Trans. Am. Ent. Soc. 10: 218.
1903. Hampson, Cat. Lep. Phal. 4: 72; sunk to *Schinia.*
1938. McDunnough, Check list, part 1, p. 105; considered a distinct genus.
1954. Forbes, Lep. New York, part 3, page 20; sunk to *Schinia.*

[3]If the *Rules* be strictly applied, these genera should be ascribed to Uhler, who validly employs them in his list of Colorado insects in the *Bulletin of the United States Geological Survey* some thirty pages preceding Grote's formal descriptions.

Dasyspoudaea Smith (new synonymy); type: *Heliothis lucens* Morr.
1882. Smith, Trans. Am. Ent. Soc. 10: 213; *lucens* designated type.
1903. Hampson, Cat. Lep. Phal. 4: 51.
1927. Draudt, Groszschmett. der Erde 7: 335.
1954. Forbes, Lep. New York, part 3, p. 25; sunk to *Rhodopsa.*

Pseudotamila Smith (new synonymy); type: *Tamila vanella* Grt.
1883. Smith, Trans. Am. Ent. Soc. 10: 238; *vanella* and *perminuta* included.
1903. Hampson, Cat. Lep. Phal. 4: 27; *vanella* cited as type.
1927. Draudt, Groszschmett. der Erde 7: 333; *vacciniae* cited as type.

Trileuca Grote; type: *Schinia trifascia* Hbn.
1883. Grote, Trans. Am. Ent. Soc. 10: 265; *trifascia* and *gulnare* included.
1903. Hampson, Cat. Lep. Phal. 4: 72; *trifascia* cited as type; sunk to *Schinia.*

Camidia Grote (nec Thompson, 1857; Holmgren, 1858; Adams, 1862); type: *Lygranthoecia scissa* Grt.
1890. Grote, Revised check list. p. 36; only *scissa* included.
1893. Smith, Bull. U.S. Nat. Mus. 44: 274, 285; sunk to *Schinia.*
1903. Hampson, Cat. Lep. Phal. 4: 15; sunk to *Heliothis.*

Eupanychis Grote (new synonymy); type: *Heliothis spinosae* Gn.
1890. Grote, Revised check list, p. 34; only *spinosae* included.
1903. Hampson, Cat. Lep. Phal. 4: 94.
1927. Draudt, Groszschmett. der Erde 7: 343.
1954. Forbes, Lep. New York, part 3, p. 25.

Trichosellus Grote; type: *Heliothis cupes* Grt.
1890. Grote, Revised check list, p. 36; only *cupes* included.
1893. Smith, Bull. U.S. Nat. Mus. 44: 274; sunk to *Schinia.*
1902. Dyar, Bull. U.S. Nat. Mus. 52: 187; considered a distinct genus.

Thyreion Smith (new synonymy); type: *Aedophron snowi* Grt.
1891. Smith, Trans. Am. Ent. Soc. 18: 121; *snowi* and *rosea* included.
1895. Grote, Check list, p. 65; sunk to *Aedophron.*
1903. Hampson, Cat. Lep. Phal. 4: 57; *snowi* cited as type; considered a distinct genus.
1927. Draudt, Groszschmett. der Erde 7: 336.

Incita Grote (new synonymy); type: *Annaphila aurantiaca* Hy. Edw.
1895. Grote, Abh. Nat. Ver. Brem. 14: 111; *aurantiaca* designated type.
1907. Smith, Jour. N.Y. Ent. Soc. 15: 141.
1927. Draudt, Groszschmett. der Erde 7: 333.

Palada Smith (new synonymy); type: *Palada scarletina* Sm.
1900. Smith, Proc. U.S. Nat. Mus. 22: 486; only *scarletina* included.
1927. Draudt, Groszschmett. der Erde 7: 327.

Chlorocleptria Hampson (new synonymy); type: *Schinia simplex* Sm.
1903. Hampson, Cat. Lep. Phal. 4: 50; *simplex* designated type.
1927. Draudt, Groszschmett. der Erde 7: 335.

Thorax and head, including palpi, with mixed scales and hair. Frons generally weakly scaled. Nocturnal species usually with more scaling and less hair on head and thorax than diurnal species. Legs with both scales and hair. Scaling of abdomen variably overlaid with hair, usually lightly so dorsally, more heavily so laterally and ventrally. Anal tuft consisting of mixed scales and hair.

Frons bulbous, smooth, without tubercles, troughs, or ridges but with transverse depression below centre and an excurved free ventral lip (Figs. 3, 4). Eye naked, unlashed, ranging from large, globular to small, elliptoid. Antenna scaled above, ciliated below. Palpus upcurved, terminating before frons, terminal segment often somewhat projecting; great individual variation in length, thickness, and proportions of segments; basal segment usually longest and distal shortest although basal and middle segments often of essentially equal length. Tongue long and well developed.

Foretibia armed with curved claws or spines, at least an inner terminal claw or spine always present. Commonly other uncurved spines present on foretibia. Mid and hind tibiae spined (Fig. 1).

Great interspecific variation in maculation. In well-marked species, macu-

lation more or less typical of trifid noctuids except that orbicular spot of forewing tends to fuse with basal space and reniform is closer to base of wing than in most noctuids; hind wing ranging from unmarked, to prominently marked with broad outer costal band and large discal spot. Highly coloured species often lacking typical maculation. A few species essentially immaculate. In some species, in which maculation seemingly obliterated, an occasional specimen with normal spots and lines readily discernible. Venation typical of trifid noctuids (Fig. 2).

Abdominal brushes present or absent. Valve of male genitalia simple, straplike with apical corona consisting of six to 30 or so setae; corona apparently absent in *Schinia scissa* (Grt.). A short, fingerlike ampulla generally present near middle of valve, absent in a few species. Juxta variable in shape. Anellus with or without paired sclerites. Uncus elongate, slender, with small terminal hook. Penis consisting of rather short, slightly curved aedeagus and coiled, unembellished vesica, proximal portion of the latter generally somewhat enlarged; vesica with or without basal diverticulum.

Valves of female genitalia bilaterally flattened, generally knife-like and heavily sclerotized. Ninth segment leathery, clothed with spicules. Bursa copulatrix consisting of a membranous baglike fundus and a coiled appendix; fundus bursae with one to four elongate or oval signa; appendix bursae with one to four coils.

The sinking of a goodly number of previously recognized heliothidine genera may at first appear to be somewhat radical. The morphological homogeneity of the species herein included in *Schinia*, however, indicates their close relationship.

The greatest single difference among the species is the variation in size of the compound eye. Other morphological evidence, however, suggests that change in the size of the eye has occurred a number of times in the lines that gave rise to our present forms. *Schinia edwardsi* (Sm.) and *spinosae* (Gn.), for example, are none too closely related species that have similar, only partially reduced eyes.

Another difference is in the colour and maculation of the wings, which vary considerably from species to species. The deviation from the typical noctuiform maculation, however, is presumably a protective adaptation and probably does not have a great deal of phylogenetic significance. Analysis of other morphological features revealed no other difference that may be considered of generic importance.

In North America, the genera *Schinia* and *Heliothis* comprise the bulk of species referable to the Heliothidinae. The two are similar in appearance and habits. Morphologically, however, *Heliothis* differs from *Schinia* in the following features:—

Foretibia usually with slender, straight or weakly curved spines, unlike the thick, curved claws of most species of *Schinia*. Aedeagus strongly pointed apically. Everted vesica joining aedeagus almost at right angles; straight or weakly coiled and bearing an elongate, scobinated bar near its base. Ovipositor valves usually somewhat thicker and more membranous than the flattened, sclerotic ones typical of *Schinia*. Appendix bursae an uncoiled, weakly membranous sac.[4]

[4]This description is not applicable to *Heliothis armigera* (Hbn.) and the complex of species associated with it. In my opinion, *armigera* is not congeneric with *dipsacea*, the type species of *Heliothis*.

In distinguishing between species in this work, great confidence was placed in similarity of structure of the male and female genitalia. Although the genitalia exhibit both individual and geographic variation, they generally vary less than such features as size and maculation.

In the male genitalia, the shape of the valve, the number and arrangement of setae constituting the corona, the presence or absence and (if present) the length of the fingerlike ampulla are all of value in specific diagnosis. The shape of the juxta, and the presence or absence of sclerotized plates in the membranous anellus encircling the penis, are also generally stable characters. The uncus, which often exhibits valuable specific differences, is in most species of *Schinia* slender and elongate with a small hook at its terminus.

In the female genitalia, the shape of the valve of the ovipositor, the size and number of setae on the valve, and the spiculation of the penultimate segment are generally reliable in distinguishing species. Features of the female genitalia, however, are often not so easy to define as those of the male genitalia. The signa on the bursa copulatrix are very unstable both in shape and in number and must be used with caution in postulating specific differences. Among species of *Schinia* examined, there are a maximum of four elongate or oval signa.

The number and size of spines and claws on the foretibia, although often showing considerable individual variation, are valuable external features to use in conjunction with maculation and colouring to separate species.

On the abdomen of many species of *Schinia*, as well as of many other noctuid moths, there are a pair of elongate hairy processes termed by Eltringham (1925) the abdominal brushes. Each of these structures is borne on an arm of the sternum of the second abdominal segment and fits into an elongate pocket of the body wall that opens between the second and third abdominal segments. Abdominal brushes occur sporadically throughout the genus and do not appear to have any group significance.

KEY TO ELLIPTOID-EYED SPECIES

The elliptoid-eyed species of *Schinia* differ most fundamentally from species of *Heliolonche* Grt. and *Heliosea* Sm. in the structure of the male genitalia. Because it is practically impossible to separate the latter two genera from *Schinia* on the basis of external features, they are included in the following key. Moreover, whereas the majority of species presented in the key have about half a dozen spines on the mid and hind tibiae, *Schinia aurantiaca* and the species referable to *Heliolonche* and *Heliosea* have only one or two spines at the apices of the mid and hind tibiae. Species and genera in the key may be characterized as follows:—

Mid and hind tibiae spined, at least at apices. Foretibia with enlarged, curved claw or claws in addition to slender spines. Frons smooth, with a projecting ventral shelf or lip. Eyes small, elliptoid, naked, and unlashed; usually about half as wide as frons. Gena unscaled anterior and ventral to the eye, scaled posterior to the eye.

1. Foretibia unarmed except for inner and outer terminal claws; mid and hind tibiae with only one or two apical spines 2
   Foretibia with slender accessory spines in addition to inner and outer terminal claws; mid and hind tibiae with at least six spines each 3
2 (1). Reniform and orbicular spots of forewing undefined (not considered in this paper) ..... *Heliosea* Sm., *Heliolonche* Grt.
   Reniform and orbicular spots of forewing well defined ..... *Schinia aurantiaca* (Hy. Edw.)
3 (1). Hind wing entirely brown or black 4
   Hind wing white, cream, yellow, or orange centrally 11

4 (3). Foretibia with two inner terminal claws of essentially similar size (Figs. 8, 19) 5
Foretibia with only one inner terminal claw 6
5 (4). Forewing greyish-brown marked with white ..... *dobla* (Sm.)
Forewing orange-brown ..... *mitis* (Grt.)
6 (4). Wings suffused with pink or red beneath 7
Wings not suffused with pink or red beneath 9
7 (6). Forewing almost immaculate, reddish-purple ..... *indiana* (Sm.)
Forewing greenish-brown to light chocolate-brown 8
8 (7). Foretibia armed with one or two outer spines (Fig. 15); valve of male genitalia broad apically (Fig. 35); penultimate segment of female abdomen clothed with scale-like processes (Fig. 70) ..... *scarletina* (Sm.)
Foretibia armed with three or four outer spines (Fig. 13); valve of male genitalia narrow apically (Fig. 30); penultimate segment of female abdomen clothed with extremely fine spicules (Fig. 68) ..... *antonio* (Sm.)
9 (6). Fringe of hind wing dark, concolorous with wing ..... *avemensis* (Dyar)
Fringe of hind wing pale, contrasting with wing 10
10 (9). Underside of hind wing uniform chocolate-brown; fringe of hind wing white ..... *carminatra* (Sm.)
Apico-costal half of underside of hind wing cream; fringe of hind wing grey ..... *villosa* (Grt.) in part
11 (3). Hind wing yellow or orange centrally ..... *scissa* (Grt.)
Hind wing marked with white or cream spot or spots 12
12 (11). Foretibia with one inner terminal claw 13
Foretibia with two inner terminal claws (Fig. 9) ..... *amaryllis* (Sm.)
13 (12). Both reniform and orbicular spots of forewing defined; orbicular dark, often partially fused with basal space but always discernible 14
Only reniform spot of forewing defined; orbicular completely fused with basal space 16
14 (13). Foretibia unarmed on inner side except for single terminal claw; forewing fawn-grey; dark orbicular and reniform spots of underside of forewing contrasting with grey marginal or submarginal band ..... *triolata* (Sm.)
Foretibia with one or more slender spines on inner side in addition to terminal claw; forewing greenish-brown, or green suffused with pink or red; orbicular and reniform spots on underside of forewing concolorous with dark brown submarginal band 15
15 (14). Hind wing with white spot proximal to dark discal spot; forewing light green often suffused with red ..... *persimilis* (Grt.)
Hind wing uniformly dark brown or black from discal spot to base of wing; forewing medium to dark green, never suffused with red ..... *honesta* (Grt.)
16 (13). Apex of underside of hind wing suffused with pink or reddish-brown 17
Apex of underside of hind wing with no pink or reddish-brown suffusion 18
17 (16). Forewing brown with white or cream median space ..... *vacciniae* (Hy. Edw.)
Forewing reddish-purple with cream median space ..... *pulchripennis* (Grt.)
18 (16). Foretibia with only a single terminal claw on inner side ..... *perminuta* (Hy. Edw.)
Foretibia with one or more spines on inner side in addition to terminal claw 19
19 (18). Generally expanding less than 22 mm.; forewing never suffused with pink; ampulla of male genitalia short (Fig. 21) ..... *villosa* (Grt.) in part
Generally expanding more than 22 mm.; forewing often suffused with pink; ampulla of male genitalia long (Fig. 25) ..... *sueta* (Grt.)

RELATIONSHIPS AMONG ELLIPTOID-EYED SPECIES

Species of the genus *Schinia* constitute in both structure and habits a most homogeneous assemblage. Even the male and the female genitalia show uniformity of structure rivalled by few groups of North American Noctuidae.

This homogeneity of structure suggests that during some relatively recent period, the stem that gave rise to the present genus *Schinia* experienced a period of "explosive evolution" during which differentiation, and adaptation to specific food plants took place with great rapidity. The often close association of both adults and larvae of different species with their food plants, and the development

of protective colouration, could explain the relatively great diversity in maculation and colouring that accompanies the basic uniformity of structure.

The genus *Schinia* reaches its greatest development in North America, there being over 100 species of the genus on the continent. There are only a few species of the genus in South America, and it is even more poorly represented in other regions of the world. Among the types of 15 exotic heliothidine genera examined, only one species, *cardui* (Esp.), type of *Melicleptria*, belonged in the genus *Schinia*.

Among all the Old World species that were examined, only four species, *cognata* (Frr.), *cardui* (Esp.), *imperialis* (Staud.), and *purpurascens* (Tausch.), are congeneric with the present group. These species are distributed in southern Europe and west-central Asia. They are all elliptoid-eyed species and are evidently closely related to the more typical of the species considered in this paper. One possible explanation of this situation may be that the genus was derived from elliptoid-eyed ancestors and that diversification of the North American stem after the isolation of the Eurasian species gave rise to the globular-eyed, nocturnal species of the genus. The globular-eyed condition, presumably a primitive one in the Noctuidae, in this event would be secondarily derived by the nocturnal species of *Schinia*.

Another explanation of the situation might be that the elliptoid-eyed condition of the Eurasian species has been derived independently from that condition in the more generalized North American species. The relative closeness of the two groups, however, would not greatly support this assumption.

A third interpretation might be that both diurnal and nocturnal species were once represented in Europe and North America, but that the nocturnal species were subsequently displaced in Europe and became extinct. Such an explanation does not seem satisfactory, however, for what is conceived as a relatively recent group.

A fourth and possibly the most plausible explanation presumes that *Schinia* is of North American origin. The more generalized elliptoid-eyed species or their antecedents may have been stronger and more active fliers or they may have migrated from this continent during a climatic period when night-time temperatures or other conditions were unsuitable for the migration of nocturnal species.

Because of the homogeneity in structure of species of the present group, it is difficult to indicate relationships by conventional methods. Certainly nothing resembling a linear trend is evident in the group. The phylogenetic tree is often used to represent the supposed evolutionary development of a group of species. The fabrication of such trees, however, based on the morphology of extant forms and in most instances without reference to any geological record is a rather dangerous form of speculation. Even if a worker's knowledge of his group is of the fullest, the supposed lines of evolution probably bear little similarity to actual evolutionary courses. Some diagrammatic presentation of the evident relationships between contemporary species on the basis of comparative morphology seems preferable.

Table I gives a comparison of the elliptoid-eyed species of *Schinia* on the basis of 14 morphological features. Tables II lists the number of differences between any two species, from the total of 14 characters considered. The totals of differences between any one species and all others in the group are also indicated on Table II. Where this value of is low, the species agrees in the majority of morphological features with the other species. The lowest

TABLE I

Comparison of elliptoid-eyed species of *Schinia* on the basis of 14 morphological features.

	amaryllis	*antonio*	*aurantiaca*	*avemensis*	*carminatra*	*dobla*	*honesta*	*indiana*	*militis*	*perminuta*	*persimilis*	*pulchripennis*	*scarletina*	*suela*	*triolata*	*vacciniae*	*villosa*
Maculation of hind wing																	
Entirely dark brown or black		x		x	x	x		x	x				x				x*
Dark brown or black with white central spot(s)	x						x			x	x	x		x	x	x	x*
Dark brown or black with yellow central area			x														
Maculation of forewing																	
Typically noctuiform	x		x			x	x			x	x	x	x	x	x	x	x
Noctuiform but basic pattern somewhat obscured		x		**	x			**	**								
Abdominal brushes																	
Present	x			x		x	x				x	x		x		x	x
Absent		x	x		x			x	x	x			x		x		
Tibial claws																	
Two inner terminal claws	x					x			x								
One inner terminal claw		x	x	x	x		x	x		x	x	x	x	x	x	x	x
Male genitalia																	
Valve stout											x	x					
Valve flattened	x	x	x	x	x	x	x	x	x	x			x	x	x	x	x
Juxta shield-shaped, dorsally rounded	x		x					x									
Juxta shield-shaped, dorsally flattened		x				x			x						x	x	x
Juxta shield-shaped, dorsally pointed							x			x	x	x		x			
Juxta diamond-shaped					x												
Juxta rectangular, dorsoventrally shallow				x									x				
Coronal setae averaging less than ten		x			x		x			x			x	x			
Coronal setae averaging more than ten	x		x	x		x		x	x		x	x			x	x	x
Ampulla absent				x					x				x				
Ampulla short		x				x		x							x		x
Ampulla medium long	x		x													x	
Ampulla long					x		x			x	x	x		x			

*Included in both categories because both conditions evident in different subspecies.
**Maculation of forewing atypical and different from that of any other species.

TABLE I (CONTINUED)

Comparison of elliptoid-eyed species of *Schinia* on the basis of 14 morphological features.

	amarylis	*antonio*	*aurantiaca*	*avemensis*	*carminatra*	*dobla*	*honesta*	*indiana*	*mitis*	*perminuta*	*persimilis*	*pulchripennis*	*scarletina*	*sueta*	*triolata*	*vacciniae*	*villosa*
Diverticulum of vesica present						x	x				x	x					
Diverticulum of vesica absent	x	x	x	x	x			x	x	x			x	x	x	x	x
Annelus with paired sclerites				x	x												
Annelus without paired sclerites	x	x	x			x	x	x	x	x	x	x	x	x	x	x	x
Female genitalia Signa absent				x					x				x				
Signa elongate	x		x			x	x	x		x	x	x		x	x	x	x
Signa short, oval		x			x												
Penultimate segment sclerotized	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x
Penultimate segment membranous										x							
Spicules on penultimate segment fine	x	x	x	x				x		x	x	x		x			
Spicules on penultimate segment coarse					x	x	x								x	x	x
Spicules on penultimate segment very coarse									x								
Spicules on penultimate segment scalelike													x				
Valve pointed							x					x		x		x	
Valve sharply rounded	x					x			x	x			x		x		x
Valve broadly rounded		x	x	x	x			x			x						

values obtained were those of *villosa* and *triolata;* the highest those of *mitis* and *carminatra.*

With points indicating the positions of species, and the number of morphological differences indicating the distance between points, the relationships of the elliptoid-eyed species of *Schinia* are suggested in Fig. 146. The numbers of morphological differences between one species and other species, when expressed in terms of distance between species points, are not such that the point representing one species can be placed the exact distance from points representing other species. A multi-dimensional diagram would be required for this purpose. The point representing any one species, therefore, is so placed that the distances between it and points representing other species, best approximate the number of morphological differences between it and other species.

TABLE II

Number of morphological differences, from total of 14, between elliptoid-eyed species of *Schinia*.

	villosa	*triolata*	*vacciniae*	*sueta*	*aurantiaca*	*amaryllis*	*indiana*	*honesta*	*perminuta*	*persimilis*	*dobla*	*pulchripennis*	*antonio*	*scarletina*	*avemensis*	*mitis*	*carminatra*
villosa		1*	2	5	6	4	5	5	6	6	2	6	6	6	7	6	8
triolata	1		3	6	5	5	5	6	5	7	4	7	6	6	9	6	8
vacciniae	2	3		4	5	4	7	4	7	6	5	5	8	8	8	8	9
sueta	5	6	4		6	5	7	2	3	4	8	3	7	7	8	10	8
aurantiaca	6	5	5	6		4	3	8	6	6	8	7	6	7	7	8	8
amaryllis	4	5	4	5	4		6	7	6	6	5	6	9	8	8	7	11
indiana	5	5	7	7	3	6		9	7	7	7	8	4	7	6	7	7
honesta	5	6	4	2	8	7	9		5	4	6	3	9	8	10	11	8
perminuta	6	5	7	3	6	6	7	5		6	9	6	7	6	10	9	8
persimilis	6	7	6	4	6	6	7	4	6		7	1	9	10	8	11	10
dobla	2	4	5	8	8	5	7	6	9	7		7	8	8	9	6	10
pulchripennis	6	7	5	3	7	6	8	3	6	1	7		10	10	9	11	11
antonio	6	6	8	7	6	9	4	9	7	9	8	10		6	7	7	4
scarletina	6	6	8	7	7	8	7	8	6	10	8	10	6		6	5	7
avemensis	7	9	8	8	7	8	6	10	10	8	9	9	7	6		7	7
mitis	6	6	8	10	8	7	7	11	9	11	6	11	7	5	7		9
carminatra	8	8	9	8	8	11	7	8	8	10	10	11	4	7	7	9	
Total of differences	81	89	93	93	100	101	102	105	106	108	109	110	113	115	126	128	133

*For example, *villosa* and *triolata* are different in only one of the 14 morphological features listed in Table I.

Conclusions based on Table II must, of course, be accepted with reservation. In the first place the various morphological features chosen are probably not of equal phylogenetic significance. Variations in the shape of the juxta, for example, would probably result from greater genetic change than an increase in the number of setae in the corona.

Secondly, the alternatives within categories of characters are often not of equal value. Thus, variations in length of ampulla probably do not have the significance of presence or absence of that structure. A system of weighting or double categorizing might increase the significance of the scores but was avoided in the analysis. The more complex the system of comparison becomes, the greater is the danger of increased subjectiveness.

In addition to these criticisms there is yet another that may be directed at the system used. The lack of consideration given to other species characters may throw the relationship picture entirely awry. Much data concerning immature stages and development may not be available to the worker. In other

instances, certain nebulous or difficult to define characters cannot be summarized or categorized in a brief analysis and must be ignored.

Nevertheless, the relationships indicated, are probably in a general way valid. As seen in Figure 146, species such as *villosa*, *triolata*, and *vacciniae* are closest to the centre of the group and may be considered as most representative. Species occupying peripheral positions such as *mitis* and *carminatra* evidently represent more specialized forms and are probably not so closely related to *villosa* and *triolata* as are a great many of the nocturnal species of the genus.

Because *villosa* and *triolata* agree with the other species in the greatest number of morphological features, it does not follow, of course, that they most closely approximate the primordial stem that gave rise to species of the group. In this connection, however, it is noteworthy that *Schinia villosa* and *sueta* occupy central positions in the diagram indicating relationships. These two species suggest by their wide geographical variation that they are most evolutionarily active at the present time.

SIZE AND STRUCTURE OF THE EGG

Various attempts have been made to distinguish and systematically describe lepidopterous eggs. Usually such descriptions consist of analyses of colour, general shape, and grosser morphological characteristics. Crumb (1929) distinguished the eggs of cutworms on tobacco by using their dimensions, the number of ribs radiating from the micropyle, and the colour. Sarlet (1949) proposed an elaborate system and described a large number of eggs of the Lycaenidae according to it. The intensive study of the reticulations on the chorion of the eggs of Noctuidae by Seamans (1933) is discussed in a later section of the present paper.

The noctuid egg is commonly spherical, hemispherical, ovoid, or conoid, with prominent "ribbing" radiating from the micropyle on the anterior, or upper, surface. The egg is also typically low (or short) and wide. Crumb (1929) described the eggs of some 20 species representing four subfamilies of Noctuidae, and in all these species the egg is somewhat wider than it is high.

Heliothidine eggs may be spherical, ovoid, or elliptical. The eggs of those species that oviposit in the heads of their food plants are generally elongate, whereas the eggs of those species ovipositing at random on the heads are generally short and broad. *Heliothis phloxiphaga* G. and R., *H. zea* (Boddie), and *Schinia florida* (Gn.) do not have elaborate oviposition habits and their eggs, being short and broad, are roughly spherical. Among the elliptoid-eyed species of *Schinia*, eggs are usually elliptical, and frequently smooth except for the anterior (or upper) surface, which may be somewhat corrugated or dimpled. The elongate shape probably facilitates deposition in flower heads, and the absence of ribbing may be a response to the compression and distortion which the egg often experiences as a result of being deposited in an extremely confined space.

Eggs were obtained for study by removing them from the heads of food plants, by dissecting them from females preserved in alcohol, and by dissecting them from the abdomens of dried museum specimens that had first been softened in a solution of trisodium phosphate. This chemical was the only one tested that would soften body tissues without destroying the chorions.

The abdomen was first snipped or broken from a dried female specimen and immersed in a ten per cent aqueous solution (by volume) of trisodium phosphate for three days. The abdomen was then placed in water, the body wall slit, and

the eggs removed. It was necessary to cut the body wall laterally or dorsally so that there was no danger of accidentally severing the ductus bursae. On removal of the eggs, the female genitalia and body wall were treated with potassium hydroxide and cleaned in preparation for mounting on a slide.

Eggs dissected from the abdomen became enlarged on transfer from the trisodium phosphate solution to water, presumably as a result of osmosis. However, a corresponding decrease in size was observed after dissected eggs had been stored for a period in 70 per cent alcohol. To estimate the amounts of distortion caused by various chemicals, a series of measurements were made of the eggs of one of the commonest heliothidine moths, *Schinia florida* (Gn.).

The lengths (from micropyle to posterior end) and widths (through the equator) of batches of 24 to 30 eggs laid by eight females from the Ottawa region were measured when laid, and again after being preserved in 70 per cent alcohol for two weeks. The eggs did not change significantly in length after being preserved in alcohol but did increase in width by 6.0 ± 1.9 per cent.

The measurements of deposited eggs were compared with those of similar batches dissected from dried museum specimens of the same species from the same locality. The eggs were measured on removal from the trisodium phosphate solution and again after being preserved in 70 per cent alcohol for two weeks. It was found that the eggs were 25 ± 3.9 per cent longer, and 17.9 ± 3.3 per cent wider, on removal from the trisodium phospate solution, than the similar batches of freshly deposited eggs.

There was, however, no significant difference between means of preserved deposited eggs, and of preserved dissected eggs for either lengths or widths. These two groups were, therefore, considered to represent the same condition as to size.

In the discussion of egg characteristics under the species headings in the text of the present paper are listed the dimensions of the sample of eggs which were studied for that species. In the listing of these dimensions the length of the egg is always given before the width. These are the dimensions of eggs preserved in 70 per cent alcohol, either exclusively dissected eggs, or both deposited and dissected eggs. Where both deposited and dissected eggs were available for study their dimensional values have been combined because of the lack of significant difference between the means of samples representing these two categories in *Schinia florida*. These dimensional values must, however, be accepted with considerable reservation. As indicated by the study of the eggs of *Schinia florida* the dimensions of preserved eggs are probably not those of freshly deposited eggs, at least for the width. Moreover, as indicated by the same study, the eggs of one female may differ significantly from those of another and in most cases the small number of females whose eggs were studied, cannot be construed as adequate to represent either the species or the population to which they belong.

To submit the eggs of the elliptoid-eyed *Schinia* to more detailed study a technique first developed by Seamans (1933) for the microscopic examination of the reticulation on the chorion of the noctuid egg was employed. The chorion design, readily discernible in transmitted light, consists of cell-like areas separated from one another by thickened ridges termed by Seamans the cell walls. This pattern is evidently the outline of the cells of the follicular epithelium which has been impressed on the chorion before or during the hardening of the latter.

Those eggs required for study of chorion design, which were obtained from captive females or had been dissected from preserved or dried specimens,

were bisected through the equator and the posterior half discarded. The contents of the anterior half were then removed and the hemisphere of chorion placed in a five per cent (by volume) aqueous pepsin solution for a period of one day. The latter step might not be necessary in the case of deposited eggs but in many dissected eggs the chorion was partially covered externally by a protein scum which was, presumably, the remnants of the follicular epithelium. The pepsin solution partially digested and loosened this coating in many cases so that it could be peeled from the chorion without too much difficulty.

The eggs were removed from the pepsin solution to 30 per cent alcohol for subsequent manipulation. Remnants of the follicular epithelium were removed from the chorion with needle or fine forceps. A series of radial slits were then made in the chorion from the cut edge toward the micropyle. This cutting of the chorion was necessary so that the hemisphere might be flattened for mounting without folds or wrinkles forming through the micropylar region. The segment of chorion was subsequently dehydrated in ethyl alcohol, cleared and stained in an oil of clove-saffranin solution, and mounted in Canada balsam.

The cells immediately surrounding the micropyle are termed the primary cells. The next row from the micropyle constitutes the secondary cells and so on. The primary cells are elongate and wedge-shaped and are arranged in the form of a rosette. The narrow inner ends of the primary cells form the walls of the micropyle and the outer margins are rounded. The second series of cells generally are also elongate with the narrower inner ends directed toward the micropyle. The third and fourth series of cells may be similar to those of the second series but generally they are shorter and broader and often roughly quadrate or pentagonal in shape. In the eggs of many species of noctuids the cells beyond the third or fourth series become regularly quadrate and are arranged in columns radiating from the micropylar area. The walls dividing the adjacent columns of cells are the often described "ribs" of the noctuid egg.

In addition to the cell-like reticulum on the chorion described above there are also smaller, roughly circular areas occurring at the angles of the larger cells and along the ribs of the egg. These have been termed respectively angle cells and rib cells by Seamans. Because these are apparently actual openings through the chorion, however, the term pores would seem preferable and has here been employed.

The eggs of the elliptoid-eyed *Schinia* are distinguished from many noctuid eggs by the great reduction in the amount of reticulation visible on the egg. This has resulted in the typical smoothness of eggs of species of this group previously alluded to. Often the columnar cells are wanting entirely. *Schinia indiana* (Sm.) is the one species of the present group in which the lateral ribbing of the egg is well expressed. Even in this species, however, the cross- or radial walls of the cells are usually absent. In *Schinia persimilis* (Grt.) evanescent cell walls may be evident on the lateral wall of the egg. In this species the columnar cells are irregularly arranged and there are no straight ribs. In *Schinia sueta* (Grt.) there are usually no cell walls evident beyond the third or fourth series of cells, but the angles of cells to the ninth to twelfth series are marked by prominent pores.

In some species the lateral chorion wall instead of being divided into columnar rows of cells or being smooth is divided into irregularly arranged hexagonal or pentagonal cells. The eggs of *Schinia honesta* (Grt.) (Fig. 81) may be cited as an example in the present group. Crumb (1929) records the same condition in the eggs of *Lacinipolia meditata* (Grt.).

It may well be argued that eggs dissected from a female do not illustrate the final morphological condition of the deposited egg. In the dissected abdomen there are commonly eggs of many sizes. Only the fully developed of these, however, will have the hardened chorion present. When it is considered that one of these moths may lay well over a hundred eggs in a single day, it is not surprising that there are usually a number of fully formed eggs in collected museum specimens. A simple criterion has been used to distinguish the fully developed eggs from the partially formed ones. The trisodium phosphate solution evidently enters the egg during the three day softening process to which the abdomen is submitted. When the abdomen is dissected in water the individual egg swells presumably as a result of the entrance of water, the chorion acting as a semi-permeable membrane. Only the eggs that exhibited this phenomenon were considered suitable for subsequent chorion design analysis.

In the present study, series of dissected eggs and series of deposited eggs have been compared for five species, *Schinia dobla* (Sm.), *pulchripennis* (Grt.), *sueta* (Grt.), *indiana* (Sm.), and *villosa* (Grt.). In none of these cases did the dissected eggs exhibit any more or any less development of chorion design than the deposited eggs.

While the chorion designs of the eggs of any species have definite limits of variation these limits are wide. The eggs from any one parent generally have a close similarity in the nature and extent of reticulation present. Similarly the eggs of females from any one restricted geographic region usually show considerable homogeneity. On the basis of the present study, however, the chorion design shows great latitude in the amount of intraspecific variation encountered. The nature and extent of chorion reticulation may vary considerably from individual to individual. As would be expected in organisms which have limited structural characteristics and which exhibit strong individual variability, series of eggs of different species are often not discrete. Nevertheless species norms are strongly evident in the number of primary cells forming the rosette about the micropyle; the diameter of the rosette; the number of series of cells visible from the micropyle; and the size, number and location of pores.

Because of the great variation exhibited by the chorion design in various species samples it was not thought practical to attempt to distinguish absolutely the eggs of the various species nor to prepare a key to species based on chorion design. Based as they are on the often limited series of eggs examined, the descriptions of chorion designs may not be sufficiently comprehensive to encompass the total range of variation for that species.

STRUCTURE OF THE LARVA

The larvae of the elliptoid-eyed species of *Schinia* reflect the same homogeneity of structure as do the adults. Detailed analysis of available larval material has produced few reliable specific differences. In some instances, where specific differences in size or proportion of certain structures were suspected, a series of measurements were made to determine the degree of individual variation. Actually the larvae are much more readily separable on the basis of colour, maculation, and food plant than of morphological features.

Crumb (1926) gave provisional generic characters of larvae of species of *Heliothis*. These include the combination of skin being clothed with minute spicules, setae IV and V (L1 and L2) on the prothorax being in a horizontal plane and the third joint of the labial palpus being little if any longer than the second.

This combination of morphological features is equally applicable to last

stadium larvae of *Schinia villosa* (Grt.). Other species of *Schinia* considered here differ in having the terminal segment of the labial palpus ranging up to twice as long as the median segment. Two of Crumb's morphological features defining *Heliothis* are only valid, however, in the later instars. In the first stadium larva of *Heliothis phloxiphaga* G. & R., one of the species studied by Crumb, a line through the bases of L1 and L2 is essentially parallel to the anterior margin of the prothorax. Gradually through successive stages the two setae change position until in the final instar a line through their bases is essentially at right angles to the anterior margin of the segment.

As the larvae increase in size, a similar change in position of these two setae is evident in other species of *Heliothis* and *Schinia* studied. It must not be assumed, however, that the imaginary line through the bases of the two setae is consistently or exactly at right angles to the anterior margin of the segment. In *Schinia sueta californica,* for example, a line through their bases ranges from 20 to 45 degrees from the horizontal. In *Schinia pulchripennis* it varies between 15 and 35 degrees from the horizontal.

The distal segment of the labial palpus exhibits a progressive shortening relative to the length of the median segment as the larva proceeds from stage to stage. In the first stadium larva of *Heliothis phloxiphaga* the distal segment of the palpus is over three times as long as the median segment. In the second and third instars it averages somewhat less than three times the length of the median segment. In the penultimate instar the distal segment is about one and a half times as long as the median segment. In the last larval stadium the distal segment is only slightly longer than the median segment. A similar trend is evident among species of *Schinia* from stadium to stadium as the larvae increase in size.

On the basis of available material, it was not possible to distinguish the larvae of species of *Schinia* from those of *Heliothis.* When a more comprehensive array of larval material becomes available, generic characters may be found. It will not be surprising if they are not, however, when one considers the close relationship of the two genera.

In the larvae of the species considered in this paper, the length of the prothoracic spiracle approximates the length of that on the eighth abdominal segment, the frontal pits are below a line between the bases of the frontal setae, the crotchets are uniordinal except in *Schinia sueta* in which they tend to be biordinal, and the skin is spiculate. The spiculate skin is a feature common, but not exclusive to the larvae of all species of Heliothidinae that have been reared by the author including *Eutricopis nexilis* Morr. and *Pyrrhia exprimens* (Wlk.), two species which are at present excluded from the subfamily because of the absence of spines on the tibiae of the adults. In the first and second stadium larvae of species of *Schinia* the skin is set with minute spicules of essentially equal size (Fig. 105). In the third and subsequent instars the skin is set with relatively larger spicules, usually of varying sizes, and the skin is thickened in patches giving it a somewhat cobblestoned appearance. The pigment of the spicules and skin thickenings is evidently responsible for much of the basic larval pattern. In darkly pigmented areas of the cuticle the spicules and thickenings are densely set and coloured dark brown. In pale areas of the skin the spicules and thickenings are not only unpigmented but appear to be fewer in number per unit area.

In the last stadium larva, the skin spicules of *Schinia dobla* (Fig. 106) are long and stout. In *Schinia pulchripennis* (Fig. 104), the spicules vary greatly in size, some being as large as those of *dobla.* The skin spicules of *Schinia sueta* (Fig. 101), *scarletina* (Fig. 103), and *indiana* (Fig. 102), exhibit a progressive

reduction in size from those of *dobla* and are of more uniform size than those of *pulchripennis*.

Although the skin of third and fourth stadium larvae of *Schinia triolata* is moderately heavily spiculate, the skin of fifth stadium larvae (Fig. 107) is essentially non-spiculate except on the dorsum of the eighth and ninth abdominal segments.

In the darker areas of the skin of *Schinia sueta*, *pulchripennis*, and *dobla*, the "cobblestone" thickenings are densely set. In *Schinia indiana* and *triolata* the individual thickenings are widely spaced, and the last stadium larva of *Schinia scarletina* is without evident skin thickenings.

Chaetotaxy, which has formed the basis of classification of higher categories for lepidopterous larvae, has no significance on the specific level in the present group. There is rather wide latitude in the setal arrangement of individual larvae but no interspecific variation is evident. The setal pattern of the first stadium larva differs rather radically from that of the second and subsequent larval stadia. The setal arrangement on the body of the first stadium larva is illustrated in Fig 86; that of the fifth stadium larva in Fig. 87. The typical arrangement of head setae and punctures is illustrated in Figs. 88 and 89. The setae are named according to the system proposed by Hinton (1946).

The shape of the labrum (Figs 92, 93) and the depth of the labral notch are subject to such wide individual variation that nothing of value in specific separation was evident. The mandible (Fig. 90) does not vary significantly from species to species. Several features of taxonomic significance, however, are to be found in the mouth parts of the larva. The surface of the oral portion of the median lobe of the lower lip complex, which according to Snodgrass (1935) represents the hypopharynx, is variably clothed with spicules. In addition to a heavy clothing of extremely fine, rather elongate spicules, there are also larger, more prominent spicules which are usually most numerous anterior to the series of tooth-like processes flanking the hypopharynx. In the last stadium larvae of the majority of species considered here, these larger spicules extend forward onto the anterior median surface of the hypopharynx. In *Schinia sueta* (Fig. 94) and *villosa* (Fig. 97), however, the larger spicules are commonly confined to lateral bands that converge posteriorly in the gorge.

The tooth-like processes flanking the hypopharynx are borne on plates which according to Snodgrass (1935) are sclerites of the prementum, but which are commonly termed the blades of the maxillulae by workers on lepidopterous larvae. In *Schinia scarletina* (Fig. 98) the maxillulary teeth are absent and in *Schinia triolata* (Fig. 100) reduced in size. In *Schinia villosa* (Fig. 97) they are stout and peg-like, but in the other species considered, they are flattened.

To evaluate evident differences in the size or proportion of other larval structures a number of measurements were made and a series of ratios derived from these. The means and standard deviations of these ratios for the sample representing each species and subspecies were then calculated. These ratios are presented on Tables III to VIII.

In evaluating these indices a number of factors must be considered. In the first place, a few of the structures measured, such as the labial palpus and the spinneret, are so small, especially in the early stadia, that accurate measurements are sometimes difficult. The terminal segment of the labial palpus may be set at somewhat of an angle to the basal two segments; the apex of the spinneret may be somewhat frayed and as a result unsuitable for measurement. Although the measurement of mutilated or disoriented structures was studiously

TABLE III

Facial indexes* of larvae of nine elliptoid-eyed species and subspecies of *Schinia*.

Stadium	First	Second	Third	Fourth	Fifth
sueta, northwestern subspecies	0.47±0.01 (15)	0.53±0.02 (15)	0.54±0.01 (15)	0.59±0.01 (15)	0.51±0.04 (15)
sueta californica			0.63±0.05 (15)	0.62±0.03 (15)	0.50±0.01 (6)
villosa subatra			0.62±0.04 (15)	0.62±0.02 (15)	0.64±0.02 (22)
villosa, interior B.C. subspecies			0.60±0.04 (15)	0.62±0.02 (15)	0.63±0.02 (25)
triolata			0.54±0.02 (15)	0.56±0.03 (16)	0.54±0.05 (6)
dobla			0.58±0.05 (15)	0.61±0.03 (15)	0.57±0.05 (15)
indiana			0.71±0.03 (15)	0.75±0.05 (15)	0.84±0.06 (15)
scarletina			0.61±0.03 (15)	0.61±0.04 (15)	0.61±0.04 (12)
pulchripennis			0.62±0.02 (15)	0.66±0.01 (15)	0.60±0.02 (13)

*(Length of frons + length of coronal suture) ÷ width of head, with standard deviation; number of specimens in parentheses.

avoided, they probably have, nonetheless, occasioned some error in the values of the ratios presented.

Moreover, the larvae employed in this study were the progeny of only a few females and cannot be assumed to represent the populations from which they were derived. The means and standard deviations of these restricted samples might differ significantly from those of randomly collected field samples. At least some increase in variability might be expected. Finally, the sample

TABLE IV

Epicranial indexes* of larvae of nine elliptoid-eyed species and subspecies of *Schinia*.

Stadium	First	Second	Third	Fourth	Fifth
sueta, northwestern subspecies	3.75±0.13 (15)	2.70±0.28 (15)	2.03±0.17 (15)	1.82±0.18 (15)	2.02±0.27 (18)
sueta californica			1.77±0.14 (15)	1.52±0.12 (15)	1.78±0.13 (6)
villosa subatra			1.57±0.15 (15)	1.41±0.08 (15)	1.37±0.16 (22)
villosa, interior B.C. subspecies			1.71±0.19 (15)	1.51±0.14 (15)	1.36±0.14 (25)
triolata			3.10±0.48 (15)	2.68±0.30 (16)	2.05±0.27 (6)
dobla			2.27±0.19 (15)	1.86±0.14 (15)	1.54±0.20 (15)
indiana			0.97±0.06 (15)	0.92±0.05 (15)	0.87±0.09 (15)
scarletina			2.28±0.27 (15)	1.99±0.23 (15)	1.88±0.27 (12)
pulchripennis			1.35±0.08 (15)	1.25±0.08 (15)	1.39±0.17 (14)

*Length of frons ÷ length of coronal suture, with standard deviation; number of specimens in parentheses.

TABLE V

Spinneret indexes* of larvae of nine elliptoid-eyed species and subspecies of *Schinia*.

Stadium	First	Second	Third	Fourth	Fifth
sueta, northwestern subspecies	4.4±0.6(15)	3.5±0.5(15)	3.5±0.3(15)	3.4±0.6(15)	4.3±0.6(15)
sueta californica			4.3±0.5(15)	4.1±0.4(15)	4.3±0.6(10)
villosa subatra			5.8±0.6(15)	5.4±0.6(15)	5.6±0.7(22)
villosa, interior B.C. subspecies			4.7±0.5(15)	4.6±0.5(15)	4.7±0.5(17)
triolata			3.9±0.6(10)	3.7±0.2(12)	4.3±0.4(7)
dobla			5.0±0.6(15)	5.2±0.6(15)	4.4±0.5(15)
indiana			4.1±0.8(15)	4.2±0.4(15)	3.4±0.4(12)
scarletina			6.5±0.8(15)	6.2±0.6(15)	5.0±0.5(12)
pulchripennis			3.9±0.6(13)	4.1±0.7(15)	2.6±0.4(16)

*Length of spinneret ÷ width of spinneret, with standard deviation; number of specimens in parentheses.

size is small. In some cases, however, it represents all the material that was available for study.

Apart from their value or lack of value in separating larvae of different species, the ratios presented indicate two facts of great importance. The first of these is that the relative size or proportion of various larval structures does not necessarily remain the same from stadium to stadium. Often rather an abrupt change in proportion occurs between the penultimate and ultimate larval stages. The second conclusion that may be drawn concerns the intraspecific variation that may be encountered. From a consideration of the values of the standard deviation, it is evident that the calculation and presentation of proportions based on one or two specimens may give a very inadequate if not misleading picture.

COLOUR AND MACULATION OF THE LARVA

The head of first stadium larvae of species of *Schinia* and of other heliothidines that have been reared, is usually black or dark brown. The head capsule of second stadium larvae is also usually dark brown, although somewhat lighter than that of the first instar. In the third and subsequent instars, the head capsule is usually much paler.

The prothoracic and suranal shields are usually dark in the first and second stadia larvae although somewhat paler than the head capsule. In later instars they are lighter in colour as is the head capsule. The thoracic legs are generally darker in the early instars than in the later instars.

The trunk of newly hatched larvae is generally uniform pale yellow or cream. The colour of the first stadium larvae may be somewhat altered however, subsequent to feeding, the tissues becoming stained orange or green according to the colour of the food material. The body colour of the second instar is similar to that of the first, but the dorsum may show some slight flush of the definitive colouring, and occasionally dorso-lateral lines are evident. In

the third stadium, maculation and colouring are generally well-defined, although not so complex as in later stadia.

Among the elliptoid-eyed species, certain macular bands or areas of the trunk may be consistently recognized in the later instars. Immediately above the heart is the mid-dorsal band which is commonly the darkest region of the body. Flanking the mid-dorsal band are the subdorsal areas which usually consist of pale marginal lines and a median band of darker colour. Ventro-lateral to the subdorsal area is the supraspiracular area which is usually similar in colour to, but paler than, the mid-dorsal band. Beneath the supraspiracular area, there is generally a prominent pale narrow area termed here the spiracular band. The spiracles are generally located near the dorsal margin of the spiracular band. The ventral region of the body usually has a greyish tone, especially through its median portion. The area above the legs is commonly considerably darker than the area between the legs in later instars, and for the sake of convenience the ventral region may be described as consisting of suprapodal and mid-ventral areas.

STRUCTURE AND COLOUR OF THE PUPA

Species of Heliothidinae that have been reared have the following common morphological characters in the pupa:—

Appendages of head and thorax of unequal length. Epicranial suture absent. Maxillary palpi absent. Labial palpi present. Antennae shorter than mesothoracic legs. Proboscis extending almost to apices of wings. Prothorax approximately half length of mesothorax. Prothoracic femora exposed. Bases of prothoracic tibiae terminating bluntly against ocular sclerite. Mesothoracic legs not reaching apex of proboscis. Apices of metathoracic legs visible distal to apex of probiscis.

In addition to these features, the species treated in the present paper share the following pupal characteristics:—

TABLE VI

Relative lengths* of distal segment of labial palpus of larvae of nine elliptoid-eyed species and subspecies of *Schinia*.

Stadium	First	Second	Third	Fourth	Fifth
sueta, northwestern subspecies	1.46±0.17 (15)	0.98±0.11 (15)	0.78±0.08 (15)	0.71±0.06 (15)	0.54±0.08 (13)
sueta californica			0.68±0.07 (15)	0.62±0.06 (15)	0.42±0.06 (9)
villosa subatra			0.50±0.06 (15)	0.44±0.04 (15)	0.33±0.06 (15)
villosa, interior B.C. subspecies			0.50±0.05 (15)	0.38±0.06 (15)	0.27±0.03 (13)
triolata			0.59±0.08 (9)	0.59±0.07 (11)	0.46±0.05 (7)
dobla			0.70±0.07 (15)	0.39±0.06 (15)	0.35±0.04 (15)
indiana			0.61±0.12 (15)	0.61±0.06 (15)	0.49±0.03 (12)
scarletina			1.01±0.09 (15)	0.83±0.11 (15)	0.58±0.03 (12)
pulchripennis			0.77±0.07 (10)	0.71±0.08 (15)	0.47±0.09 (14)

*Length of distal segment of labial palpus ÷ length of proximal segment, with standard deviation; number of specimens in parentheses.

Spiracles on a plane with general surface of cuticle or located in shallow depressions but not sunk into pits. Abdominal segments five to seven pitted. Cremaster consisting of two or four slender spines arising from conical apex of tenth abdominal segment.

Pupal coluring is surprisingly characteristic in the species of Heliothidinae studied. When the pupa first frees itself of the last larval skin it is a pallid creamish-white but darkens within a few hours to its definitive colouring; yellow, orange and shades of brown being found in the species studied. One of the most striking of these is the pupa of *Dysocnemis oregonica* Hy. Edw., which is deep brown with a bright green flush on the wings and appendages. The green colouring is maintained until shortly before the adult emerges.

To give some indication of the relative size of pupae studied, the distance between the apex of the head and the posterior margin of the rigid sclerotic ring of the fourth abdominal segment has been measured. The compressibility of the abdomen between the 4th and 5th, 5th and 6th, and 6th and 7th segments makes it impractical to measure the entire length of the pupa. In general the measured length bears a moderately close relationship to the size of the adult of the species or subspecies although the pupae of some species are stout in comparison with those of other species.

The relative lengths of caudal and thoracic appendages offer reliable characters for specific diagnosis. The length of the mesothoracic legs in relation to the length of the proboscis is very significant. The relative lengths of proboscis and metathoracic legs (as indicated by the length of metathoracic leg visible posterior to the apex of the proboscis) is of some value but must be used with caution because of individual variation.

Unfortunately pupal setae vary in their degree of expression. Some setae are prominent and readily distinguished. Others are represented only by darker spots on the surface of the cuticle. On pitted cuticle the setae are usually located at the bottom of pits and as a result are often difficult to

TABLE VII

Crotchet indexes* of larvae of nine elliptoid-eyed species and subspecies of *Schinia*.

Stadium	First	Second	Third	Fourth	Fifth
sueta, northwestern subspecies	24.3±1.5 (15)	17.3±1.5 (15)	20.1±1.4 (15)	16.0±0.4 (15)	11.1±0.5 (17)
sueta californica			19.9±1.9 (12)	12.8±0.2 (6)	9.2±0.2 (6)
villosa subatra			17.1±0.6 (13)	13.6±1.3 (9)	10.1±0.7 (18)
villosa, interior B.C. subspecies			11.5±1.3 (8)	11.7±0.3 (7)	9.4±0.7 (25)
triolata			12.3±2.6 (3)	10.1±1.2 (3)	7.1±0.5 (6)
dobla			13.0±1.6 (6)	8.6±1.4 (7)	7.3±1.0 (15)
indiana			16.7±2.2 (15)	12.8±1.5 (15)	11.7±1.3 (15)
scarletina			17.0±2.1 (9)	12.9±2.3 (10)	8.8±1.0 (12)
pulchripennis			13.3±0.5 (7)	10.3±0.3 (6)	7.6±0.4 (13)

*Number of crotchets on first proleg ÷ ½ (width of head + length of frons + length of coronal suture) in mm., with standard deviation; number of specimens in parentheses.

TABLE VIII

Spiracle indexes* of larvae of nine elliptoid-eyed species and subspecies of *Schinia*.

Stadium	First	Second	Third	Fourth	Fifth
sueta, northwestern subspecies	0.084±0.005 (5)	0.080±0.006 (15)	0.104±0.007 (15)	0.119±0.003 (15)	0.121±0.003 (15)
sueta californica			0.103±0.002 (12)	0.105±0.005 (6)	0.118±0.003 (16)
villosa subatra			0.060±0.002 (13)	0.077±0.002 (9)	0.093±0.004 (22)
villosa, interior B.C. subspecies			0.063±0.006 (8)	0.087±0.008 (7)	0.097±0.006 (15)
triolata			0.083±0.008 (3)	0.074±0.003 (3)	0.075±0.007 (6)
dobla			0.057±0.005 (6)	0.066±0.005 (7)	0.088±0.007 (15)
indiana			0.066±0.011 (15)	0.095±0.009 (15)	0.123±0.010 (15)
scarletina			0.058±0.003 (9)	0.072±0.006 (10)	0.080±0.008 (12)
pulchripennis			0.070±0.008 (7)	0.085±0.005 (6)	0.084±0.005 (13)

*(Length + width of spiracle on first abdominal segment) ÷ (width of head + length of frons + length of coronal suture), with standard deviation; number of specimens in parentheses.

discern. Consequently, setal characters have been largely ignored in the present analysis.

The presence or absence of seta L2 on the fourth abdominal segment has been noted, however, because of its prominence when present on the surface of the cuticle. In the majority of species studied here the seta is covered by the wing, it often being visible through the latter near the outer margin. In some specimens of these species, the wing is not fully developed at pupation and the seta may be found in the membranous channel left unoccupied by the underdeveloped wing. In *Schinia sueta* and *Schinia dobla*, however, the seta is on the surface of the cuticle beyond the outer margin of the wing. In the latter species it is represented only by a darkly pigmented spot.

The size of the pits on abdominal segments 5 to 7, the density of these pits, and the relative extent of the pitted areas on these segments are good specific characters. In addition to the pitting, the presence or absence of punctations on other abdominal segments and the relative density of these differ from species to species.

The spines of the cremaster are evidently the homologues of setae D2 or setae D2 and L1 on the suranal shield of the larva. In *Schinia sueta*, *dobla*, *indiana* and *scarletina* both pairs of setae are represented in the cremaster. In *Schinia villosa*, *triolata* and *pulchripennis* only the median pair, D2, are normally represented. That the spines of the cremaster are subject to the same instability as are larval setae, however, is attested to by the fact that the occasional specimen of those species which normally have only two spines may have vestigial third or fourth setae adjacent to the median pair. The latter presumably represent the outer setae on the posterior margin of the suranal shield of the larva.

SCHINIA VILLOSA (GROTE)

1864. Grote, Proc. Ent. Soc. Phil. 3: 531; *Melicleptria.*
1870. Grote, Trans. Am. Ent. Soc. 3: 181; *Anthoecia.*
1873. Grote, Trans. Am. Ent. Soc. 4: 432; *Heliothis.*

1883. Smith, Trans. Am. Ent. Soc. 10: 244; *Melicleptria.*
1893. Smith, Bull. U.S. Nat. Mus. 44: 288.
1903. Hampson, Cat. Lep. Phal. 4: 20; *Heliothis.*
1912. Barnes & McDunnough, Contrib. Nat. Hist. Lep. N.A. 1(4): 39.
1927. Draudt, Groszschmett. der Erde 7: 332; *Melicleptria.*

pauxillus (Grote)
1873. Grote, Bull. Buff. Soc. Nat. Sci. 1: 118; *Heliothis.*
1875. Grote, Check List Noctuidae, p. 18; sunk to *villosa.*

Forewing medium chocolate-brown, dark grey-brown, or golden olive-brown, with cream, white, or grey median space. Median space in some specimens darkly suffused. Hind wing dark brown, with or without white central area or central spots.

Body clothed with brown and yellow scales, overlaid with greyish-yellow or olive hair. Pale-yellow or fawn-grey annuli commonly present at posterior margins of abdominal segments. A tuft of pale-yellow hair at terminus of abdomen. Beneath, vestiture of body fawn-yellow or fawn-grey.

Transverse anterior line yellow or yellow-grey, in many specimens its middle portion fusing with median space; in some specimens marked only by colour change; broadly excurved but usually with a shallow inward arc opposite the reniform. Basal space brown or golden-olive with some grey scaling at immediate base of wing. A short, weak, yellow or grey basal line present in many specimens. Transverse posterior line yellow or greyish-yellow, often fusing with median space; bisinuate, usually weakly so, excurved anteriorly, incurved posteriorly. Median space cream, white, or fawn-grey, variably overlaid with olive or brown scaling and commonly with olive or brown bands along the costal and trailing margins. In some specimens median space so heavily scaled with brownish-grey as to be practically obliterated. Reniform large, brown, commonly diffuse, usually fusing anteriorly with brown median costal band. A generally prominent circular or oval yellow spot proximal to reniform. Subterminal line pale yellow or pale fawn, a diffuse shade, irregular, turning out posteriorly to inner angle of wing; commonly with two inward teeth, one opposite cell and one near trailing margin. In some specimens s.t. line poorly defined, shading into terminal space. Subterminal space concolorous with basal space. Terminal space paler than subterminal space, severely constricted when s.t. line broad. A suggestion of a dark terminal line in some specimens. Fringe concolorous with or paler than, terminal space, often flecked with dark scaling.

Hind wing dark brown with or without white central area; the latter, if present, mostly filled by large discal spot. A narrow, short, white band along costal margin. Fringe white, pale yellow or fawn-grey.

Underside of forewing mostly dark brown with cream apex and cream median area containing large dark reniform. Often a narrow brown costal band in median area. Apico-costal half of hind wing cream; remainder brown. Discal spot prominent in light area of wing, fusing posteriorly with brown portion of wing.

Foretibia (Fig. 5) commonly with two or three inner spines and a similar number of outer spines. Male with abdominal brushes.

Male Genitalia (Figs. 21, 22).—Valve elongate, fairly flat. Corona consisting of from 12 to 30 setae arranged at apex of valve. Ampulla very short. Uncus elongate, slightly tapered from base to apex. Juxta dorso-ventrally elongate, dorsal margin straight. Vesica without basal diverticulum.

Female Genitalia (Figs. 40, 57).—Valve of ovipositor elongate, tapering to narrowly rounded apex, with a heavy clothing of short, fine setae and a few long, slender ones. Penultimate segment with short, moderately fine spicules. Commonly four elongate signa on bursa.

Distribution (Fig. 134) *and Period of Flight.*—The species ranges over much of western North America. Specimens were examined from Chihuahua, Mexico, in the south to Kamloops, British Columbia, in the north. In Canada it extends eastward to Winnipeg, Manitoba. In the United States the species has been but poorly collected east of the Cordillera.

Villosa segregates into five geographic races, specimens of which are, in many instances, readily recognizable. One subspecies is found in the intermountain valleys of the interior of British Columbia. *Schinia villosa subatra* occurs in the Northern Rocky Mountains of the United States and in the Cascades of Washington and British Columbia. *Schinia villosa sexata* inhabits the southern Prairie Provinces of Canada. *Schinia villosa villosa* ranges through the Southern Rockies of Colorado south into New Mexico and Arizona. Representatives of the most southerly subspecies have been taken in Chihuahua, Mexico. Specimens of the various subspecies examined were taken during June, July, and August.

Schinia villosa villosa (Grote)

Fig. 147

V. villosa is medium chocolate-brown with pale-yellow median space which is heavily suffused with grey scaling. The brown band on the costal margin of the median space is prominent and the white area of the hind wing is reduced to three small spots arranged in a triangle about the discal spot.

Expanse: 20.2 ± 1.4 mm.[5] (119 specimens).

Distribution and Period of Flight.—The nominate subspecies occurs in the Southern Rockies of Colorado and New Mexico and in the Sierra La Sal of eastern Utah. Specimens agreeing in general features with *villosa villosa* have also been taken in the Colorado Plateau of northern Arizona. Colorado material examined was taken at altitudes of about 10,000 feet between July 8 and August 9.

Type Material.—The type of *villosa* is not in the Academy of Natural Sciences in Philadelphia as stated by Grote in the original description, and Hampson does not mention its being in the Grote collection in the British Museum. The specimen is presumably lost. Grote cites the type of *villosa* as a female taken in Colorado. The type of *pauxillus*, also from Colorado, is a female in the Tepper collection at the Michigan State College in East Lansing. It is in generally fair condition and expands 18 mm. It was taken on July 7. The median space of the type of *pauxillus* is heavily suffused with brown scaling. There are but two white spots in the hind wing of the specimen.

Schinia villosa sexata (Smith)

Fig. 148

1906. Smith, J. N.Y. Ent. Soc., 14: 17; *Melicleptria.*
1917. Barnes and McDunnough, Check List Lep., part 1, p. 37; considered a form of *villosa.*
1927. Draudt, Groszschmett. der Erde 7: 332.

S. villosa sexata is smaller than the nominate subspecies and the forewing is usually coppery-brown. The median space is of a creamier yellow hue than that of *villosa villosa.* The spots of the hind wing are smaller in some specimens, and in many they are absent.

Expanse: 19.0 ± 1.1 mm. (20 specimens).

[5]Standard deviation.

Distribution and Period of Flight.—The subspecies ranges across the Prairie Provinces from Edmonton, Alberta, to Winnipeg, Manitoba. I have seen but a single specimen from Saskatchewan, with no definite locality record. Specimens examined were taken between July 16 and August 4.

Type Material.—There are a male and a female specimen, labelled "type", in the American Museum of Natural History. Both are in good condition and both expand 18.5 mm. They were taken at Aweme, Manitoba, by Norman Criddle on July 21 and 28 respectively. The male is here selected as lectotype. It has two small pale spots flanking the large discal spot.

Schinia villosa subatra (Smith)

Fig. 149

1906. Smith, J. N.Y. Ent. Soc. 14: 18; *Melicleptria.*
1912. Barnes & McDunnough, Contrib. Nat. Hist. Lep. N.A. 1 (4): 39; *Heliothis.*
1927. Draudt, Groszschmett. der Erde 7: 332; *Melicleptria.*

Villosa subatra is distinguished from other races of *villosa* by the more extensive light median area of the forewing, its generally larger size, and the somewhat smoky appearance of the olive-brown of the forewing. The white spots of the hind wing are much larger than in the other races, the anterior one extending along the costal margin of the wing. Beneath, the whitish-grey areas of the wing are generally more extensive than in *v. villosa*. The male genitalia of *v. subatra* are somewhat bulkier than those of the other subspecies. Generally the corona consists of more than 25 setae rather than less than 20.

Expanse: 21.4 ± 1.6 mm. (86 specimens).

Distribution and Period of Flight.—The subspecies occurs in alpine meadows near or above treeline in the Northern Rockies of Idaho, Montana, and Wyoming and in the Cascades of Washington. In Canada it has been taken at elevations of 6,000 feet on Hope Mt., and on the slopes of Blackwall Mt. in Manning Park, British Columbia. Specimens examined were taken between July 10 and August 13. I have seen specimens with indefinite "California" labels. If these records are authentic, the specimens were presumably taken in the Sierra Nevada. The subspecies has not been taken in the Canadian Rockies.

Type Material.—There are a male and a female specimens labelled "type" at the American Museum of Natural History. The male was taken in Gallatin Co., Montana, at an elevation of 9,400 feet on July 10. The female was taken on Mt. Rainier, in Washington. Neither specimen is in very good condition. The female is somewhat better and is here selected as lectotype. It expands 20 mm.

Schinia villosa intermontana new subspecies

Fig. 150

The basic colour of this subspecies found in the interior of British Columbia, is golden-olive rather than chocolate-brown. The median space varies from white to pale yellow. There is generally much greater contrast in the forewing than in the other subspecies. The subterminal line is broad and shades outwardly into the terminal space, severely constricting or even eliminating the latter. The white of the hind wing is reduced to two or three spots flanking the reniform.

Expanse: 18.1 ± 1.3 mm. (114 specimens).

Distribution and Period of Flight.—The subspecies is plentiful in the Nicola Valley west of Merrit, B.C., at altitudes of about 2,500 feet. Larvae were also taken from the heads of *Erigeron corymbosus* Nutt. in the Twin Lakes area between the Okanagan and Similkameen valleys at about the same elevation

as the Nicola specimens were taken. The subspecies in all likelihood ranges over much of the dry intermountain plateau of the interior of British Columbia. The adult flies during June in the Nicola Lake area.

Type Material.—Holotype male, allotype female: Mt. Hamilton, 6 miles east of Nicola Lake, B.C., 2,500 ft., June 20, 1953 (J.E.H. Martin). Paratypes, 53 males, 61 females: 0.8 miles east of Nicola, B.C., 2,300 ft., June 11 - June 18, 1953 (D. F. Hardwick, J.E.H. Martin, J. R. McGillis); Nicola, B.C., June 6, 1922 (P.N. Vroom); Nicola Lake, B.C., June 18, 1922 (W.R. Buckell); Mt. Hamilton, 6 miles east of Nicola Lake, B.C., 2,500 feet, June 20, 1953 (J.E.H. Martin); Kamloops, B.C., June 1, 1937 (J.K. Jacob).

The type material is in the Canadian National Collection (No. 6279). The holotype expands 19 mm., the allotype 18 mm. In the holotype the subterminal line is narrower and the cream of the median space of a whiter tone than in the allotype.

Schinia villosa conizae new subspecies

Fig. 151

Specimens representing the Mexican Plateau subspecies of *villosa* are distinguished by the lack of contrast in the wings. The basal and subterminal spaces are essentially concolorous with those of the nominate subspecies. The median space, however, instead of being yellow or white is fawn-grey. The subterminal line is also of this colour and correspondingly lacks contrast. In some specimens the entire forewing is suffused with fawn-grey, any maculation being difficult to discern. The hind wing is uniform dark brown with pale-grey fringes. The ampulla in the male genitalia is greatly reduced in size in some specimens.

Expanse: 18.1 $\pm$ 0.9 mm. (21 specimens).

Distribution and Period of Flight.—Specimens examined were taken at Chihuahua, Mexico, between August 4 and September 4. A single specimen taken at Comfort in the Edwards Plateau region of Texas seems to combine features of the nominate and the Mexican Plateau subspecies.

Type Material.—Holotype male: Chihuahua, Mexico, August 20 (Townsend). Allotype female: Chihuahua, August 4 (Townsend). Paratypes, 16 males, 3 females: Chihuahua, August 4 to September 4. (Townsend).

The type material is in the Carnegie Museum. The holotype expands 19 mm., the allotype 18 mm. The left antenna of the holotype is lacking and the forewings are not heavily suffused with fawn-grey as are those of the allotype. The cream spot proximal to the reniform is prominent in the holotype.

Discussion

Whether the populations constituting the *villosa* complex represent a group of morphologically similar species or races of a single highly variable species is problematical. The collection and analysis of extensive material from Arizona, New Mexico, Texas, and northern Mexico might solve the problem in so far as *villosa villosa* and its Chihuahuan representative are concerned. Similarly, the study of long series from the mountains in the region of the Wyoming Basin might indicate the relationship of *v. subatra* and *v. villosa.* With *v. subatra* and *v. intermontana,* however, the problem cannot be so easily resolved. In British Columbia, *v. subatra* inhabits the lush alpine and subalpine meadowland of the Coast Ranges at an altitude of about 6,000 feet. The other subspecies inhabits the grass- and brush-land east of the Coast Ranges in the dry interior of British Columbia at altitudes between 2,000 and 3,000 feet. How many miles apart the

closest representatives of the two forms occur might be difficult to determine. In any event they are probably separated by broad expanses of timbered land much of which would be unsuitable for the growth of species of *Erigeron*. They are further separated by a difference in period of flight of at least a month at this latitude and their habitats are separated by a difference in altitude of 3,000 to 4,000 feet.

Their behaviour patterns in the field are similar. They both become active in the late morning, fly with the same eye-dazzling speed, and mate on the blossom of the food plant or adjoining flowers late in the afternoon. They deposit their eggs between the florets of the head of *Erigeron* spp. in precisely the same way. The patterns of larval feeding, described in a subsequent section, differ little. The close similarity of behaviour of all the species of the elliptoid-eyed group, however, somewhat diminishes the vigour of this line of argument.

Except for slight differences in the valve of the male genitalia and minor differences in colour and maculation, the forms are morphologically identical. Moreover, it must be remembered that *v. subatra* and *v. intermontana* are the most divergent of the subspecies in the complex.

The structure of the immature stages helps little to clarify the problem. The eggs are of the same colour and of the same proportions. The maculation of the larvae of the two forms is identical, although the colouring of *v. subatra* is deeper and richer than that of the other. Structurally they show little difference. The pupae cannot be distinguished morphologically except on the basis of size, and they are only slightly unlike in colour.

Although all these factors do not preclude the possibility of *v. subatra* and *v. intermontana* being distinct species, they do show that the two are very closely related. Hybridization experiments may help to clarify the relationship of the two.

Life History and Habits

In Manning Park, British Columbia, the larvae of *Schinia villosa subatra* feed on the heads of *Erigeron peregrinus* (Pursh) Greene. Crumb (1956) records *Aster* as the food plant of *subatra* at Mystic Lake, Washington, and *Eucephalus ledophyllus* as the food plant of *villosa* (presumably also *villosa subatra*) at Chinook Pass (Tipsoo Lake), Washington.

Larvae of *villosa intermontana* feed on the heads of *Erigeron corymbosus* Nutt. In the dry interior of British Columbia, *corymbosus* often grows in close association with *Erigeron linearis* (Hook) Piper. It is on the blossoms of the latter that the little moth commonly feeds and rests. It was at first thought, because of the close association of the two, that *linearis* was the food plant. Females confined with blossoms of this species, however, laid only a few eggs. Subsequently a female was noted in the field depositing eggs in the buds of *corymbosus*. In attempt to determine the relationship between the moth and the two species of *Erigeron* a cage approximately six feet by two and a half feet was constructed over a combined patch of the two species. Fifteen females were released within this cage. At the end of five days the cage was dismantled and all the *Erigeron* blossoms were removed. These were classified as to stage of development and the eggs were dissected from each and counted. A total of 179 eggs were laid in the 68 heads of *corymbosus* and only one egg was deposited in the 65 heads of *linearis*. Even for comparable stages of development of the two plants, the eggs were laid almost exclusively in the heads of *Erigeron corymbosus*.

However, a number of larvae were reared on *linearis* for eight days after hatching. They fed readily on this species and developed at a rate comparable to those feeding on *corymbosus*. When *linearis* was no longer available and they were transferred to *corymbosus*, they showed no higher mortality in the later stadia than did the other larvae.

A plausible explanation might be that the moth has developed in association with *Erigeron corymbosus* and its period of flight has become attuned to the early-blossom stage of that species. The aversion exhibited by the moth to laying in the head of *linearis* may not reflect any inherent unsuitability of the species as food, but may have developed because the plant matures so quickly after oviposition that there will be no blossoms available as food when the larvae have reached the later stadia.

The eggs of *villosa* are inserted by the female between the florets of the head, usually between the pappus and the corolla, rarely in the throat of a floret. In one instance the ovipositor of a female of *villosa subatra* was thrust into the head with such force that the valve cut into one of the florets and the deposited egg was left protruding from a slit in the corolla.

After hatching, the first-stadium larvae feed sparingly, if at all, on the florets and almost immediately make their way down toward the developing seeds. They generally follow a circular path in tunneling through the seed layer at the surface of the receptacle. The young larvae are extremely cannibalistic. If two larvae hatch from eggs deposited in the same blossom only one survives. It is not unusual to find the head and thorax of a larva in the same blossom with a healthy larva.

The larvae have the habit of pushing up the florets beneath which they are feeding, giving infested heads a characteristic tufted appearance. When the food material in the first blossom is exhausted, the larva, generally in the third stadium, leaves it and enters a second. The intermediate instars of both subspecies completely conceal themselves in the second and successive heads as they do in the first. The larvae of *villosa subatra* have the peculiar habit of forming a nest by hollowing out a roughly spherical area in the centre of the blossom and lining the walls with uneaten corollas and bristles. The nest-forming habit is much less strikingly developed in *villosa intermontana*.

In the last stadium, the larvae feed from outside the blossom. Those of *villosa intermontana* commonly attack the head from the side, less commonly from the top. Those of *villosa subatra* usually reach the seeds by eating through the tops of the blossoms. The last instar evidently feeds at night and hides during the day, presumably in the trash at the base of the plant. Third- and fourth-stadium larvae of *villosa intermontana* were readily found in the blossoms but last-stadium larvae were not detected.

Immature Stages[6]

Egg (Fig. 77).—Smooth except for some weak dimpling near micropyle. Pale greenish-cream when laid. No colour change evident until a few hours before hatching, when head capsule and then prothoracic shield gradually become visible at micropylar end.

Cells of primary rosette commonly irregular. Secondary cells usually well defined. Tertiaries well defined, evanescent, or absent. Quartenary cells evanescent or absent. Pores of medium size, at outer angles of cells of second, third, and fourth series, less commonly at outer angles of fifth series. Mean diameter of primary rosette of *villosa subatra*, .073 ± .007 mm.; mean number

[6]For details of larval anatomy, see "Structure of the Larva", page 28.

of primary cells, 16.2 ± 1.8 (33 eggs from 3 females). Mean diameter of primary rosette of *villosa intermontana*, .061 ± .011 mm.; mean number of primary cells, 13.3 ± 1.5 (39 eggs from 3 females).

Five females of *villosa subatra* captured at Blackwall in Manning Park, British Columbia, at 6,000 feet laid a total of 523 eggs, the maximum per female being 113. The eggs hatched in four to six days at room temperature. Four females of *villosa intermontana* from Nicola Lake, British Columbia, laid a total of 434 eggs, the maximum per female being 141. The eggs hatched in five to seven days.

Dimensions of egg: *Schinia villosa villosa*, 0.79 ± .06 mm. x 0.49 ± .03 mm. (20 eggs from 1 female; Gothic, Gunnison Co., Colo.). *Schinia villosa subatra*, 0.85 ± .06 mm. x 0.56 ± .04 mm. (112 eggs from 6 females; Blackwall, Manning Park, B.C., 6,000 ft.). *Schinia villosa intermontana*, 0.67 ± .05 mm. x 0.42 ± .03 mm. (471 eggs from 19 females; Nicola Lake, B.C.).

First-Stadium Larva.—Head medium to dark brown. Prothoracic and suranal shields somewhat paler brown. Trunk pale creamish-grey or creamish-white, often becoming yellow-stained after feeding. Prolegs and rims of spiracles dark brown.

Head capsule width: *Schinia villosa subatra*, 0.36 ± .02 mm. (50 larvae). *Schinia villosa intermontana* 0.27 ± .01 mm. (50 larvae).

Duration of stadium: *Schinia villosa subatra*, 3.2 ± 1.3 days (58 larvae). *Schinia villosa intermontana*, 3.7 ± 1.6 days (25 larvae).

Second-Stadium Larva.—Head medium orange-brown to dark brown, heavily mottled with somewhat darker brown dorsally and laterally. Prothoracic shield light brown mottled with dark brown, with a broad, whitish-grey, median line. Suranal shield essentially concolorous with prothoracic shield.Trunk dull medium grey, often with a brownish flush on the dorsum which becomes more pronounced as the larva feeds. Often a pair of paler-grey subdorsal lines visible on the trunk. Ventral region pale grey. Thoracic legs and rims of spiracles medium to dark brown.

Head capsule width: *Schinia villosa subatra*, 0.52 ± .03 mm. (50 larvae). *Schinia villosa intermontana*, 0.43 ± .03 mm. (50 larvae).

Duration of stadium: *Schinia villosa subatra*, 3.1 ± 1.4 days (58 larvae). *Schinia villosa intermontana*, 2.4 ± 1.1 days (25 larvae).

Third-stadium Larva.—Head medium orange-brown, mottled dorsally and laterally with darker brown. Generally two arcs, free of mottling, diverging upward and outward from centre of face. Prothoracic shield orange-brown or greyish-brown, lightly mottled with somewhat darker brown. A pale-yellow median line often evident. Suranal shield usually somewhat paler than prothoracic shield.

Maculation of trunk more complex than in second instar; dorsal area orange-brown to chocolate-brown, becoming progressively paler as the larva grows. Sub-dorsal area tripartite, consisting of greyish-yellow marginal lines and a median band of lighter brown than mid-dorsal band. Supraspiracular area brown, somewhat paler than mid-dorsal band. Spiracles with dark-brown rims. Spiracular and suprapodal areas concolourous with or somewhat paler than supraspiracular area. Mid-ventral area greyish-yellow or pale greyish-brown. Thoracic legs brown.

Head capsule width: *Schinia villosa subatra*, 0.77 ± .04 mm. (50 larvae). *Schinia villosa intermontana*, 0.65 ± .04 mm. (50 larvae).

Duration of stadium: *Schinia villosa subatra*, 2.9 ± 1.1 days (58 larvae). *Schinia villosa intermontana*, 2.2± 1.3 days (25 larvae).

Fourth-Stadium Larva.—Head orange-brown, mottled with darker brown dorsally and laterally. Two arcs free of mottling diverging upward and outward from centre of face. Prothoracic shield greyish-brown, variably mottled with darker brown. In *villosa intermontana*, prothoracic shield generally lightly mottled. In *villosa subatra*, prothoracic shield usually heavily mottled and suffused with dark brown. Median and submarginal longitudinal pale-yellow lines prominent on more heavily mottled shields. Suranal shield greyish-brown, usually less heavily mottled than prothoracic shield.

Trunk brown. Mid-dorsal band orange-brown to chocolate-brown. Generally darker in *villosa subatra* than in *villosa intermontana*. Mid-dorsal band often bisected, especially on meso- and meta-thorax, by a pale yellowish-grey median line. Subdorsal area consisting of three bands; marginal pair pale yellow or greyish-yellow and median band somewhat darker yellow or orange-yellow margined with brown lines; in *villosa intermontana*, median band of subdorsal area often suffused with brown. Supraspiracular area brown, somewhat paler mid-dorsal band. An irregular, longitudinal, pale-yellow median line through the supraspiracular area. In some specimens a second, evanscent, discontinuous, narrower paler-yellow or cream line present dorsal to the first. Spiracles with dark-brown rims. Spiracular band light yellow to greyish-white, usually with a broad, diffuse, median longitudinal shade of chocolate-brown. Suprapodal area light chocolate-brown, heavily mottled with pale yellow. Mid-ventral area pale greyish-brown or greyish-yellow. Thoracic legs fawn to pale orange-brown.

Head capsule width: *Schinia villosa subatra*, 1.21 ± .06 mm. (50 larvae). *Schinia villosa intermontana*, 1.00 ± .06 mm. (50 larvae).

Duration of stadium: *Schinia villosa subatra*, 4.3 ± 1.6 days (58 larvae). *Schinia villosa intermontana*, 3.8 ± 1.7 days (25 larvae).

Fifth-Stadium Larva (Figs. 177, 178).—Head light orange-brown, mottled dorsally and laterally with somewhat darker brown. A pair of arcs free of mottling diverging upward and outward from centre of face. Prothoracic shield orange-brown to yellow-fawn, variably mottled with darker shades of brown, often heavily so. In more heavily mottled specimens a median and a pair of submarginal longitudinal bands of light orange-brown or fawn-yellow readily evident. Suranal shield concolorous with prothoracic shield or somewhat paler; usually not so heavily mottled.

Mid-dorsal band medium to dark chocolate-brown. In *villosa intermontana* the mid-dorsal band often of a dull purplish-brown tone. Mid-dorsal band often bisected by a median line or shade of pale yellow, especially prominent on meso- and meta-thorax. Subdorsal area deep yellow, sometimes orange in *villosa subatra* or cream in *villosa intermontana*, trisected by a pair of longitudinal brown lines. Supraspiracular area a paler brown than mid-dorsal band, with either a diffuse median yellow shade or a pair of irregular and discontinuous longitudinal lines. Spiracles with dark-brown rims. Spiracular band creamish-white to whitish-grey with a median longitudinal brown shade or line. Suprapodal area light brown mottled with cream. Mid-ventral area yellow-grey. Thoracic legs orange-brown to fawn-brown.

Head capsule width: *Schinia villosa subatra*, 1.70 ± .08 mm. (41 larvae). *Schinia villosa intermontana*, 1.47 ± .06 mm. (50 larvae).

Duration of stadium: *Schinia villosa subatra*, 6.4 ± 1.4 days (58 larvae). *Schinia villosa intermontana*, 12.7 ± 1.9 days (25 larvae).

The tones of colouration in the later-instar larvae of *villosa subatra* are much warmer and richer than in those of *villosa intermontana*.

The significance of the excessively long last larval stadium in *villosa intermontana* and whether this is normal is not known. Mortality was very high in the last stadium in this group of rearings.

Pupa (Figs. 115-117, 190).—Slender, lightly sclerotized. Yellow-brown to pale orange-brown, with dull-red subdorsal bands for some days after pupation. Mesothoracic legs relatively long, terminating only a short distance anterior to apex of proboscis. Metathoracic legs evident as quadrate plates distal to proboscis. Seta L2 absent from surface of fourth abdominal segment. Fourth abdominal segment unpitted. Pitting on abdominal segments five to seven confined to anterior thirds of segments; pits more conspicuous because of paler cuticle, but fewer than those of *pulchripennis*. Rims of spiracles somewhat higher than those of *sueta*. Cremaster consisting of two short, slender, diverging spines. The pupa of *villosa subatra* is pale orange-brown; that of *villosa intermontana* paler, ochre.

Length to posterior margin of fourth abdominal segment: *Schinia villosa subatra*, 6.4 ± 0.3 mm. (42 pupae). *Schinia villosa intermontana*, 5.1 ± 0.3 mm. (46 pupae).

SCHINIA TRIOLATA (SMITH)

Fig. 152

1906. Smith, J. N.Y. Ent. Soc. 14: 18; *Melicleptria.*
1927. Draudt, Groszschmett. der Erde 7: 332.

Forewing brownish-grey to greenish-grey, with white or pale-grey median area. Hind wing white with brown marginal band and discal spot.

Head, thorax and abdomen black, weakly clothed with grey or olive-grey vestiture. Vestiture somewhat paler on underside of body.

Transverse anterior line white, outwardly emarginated by an incomplete line of dark scaling. In many specimens this dark scaling absent, the t.a. fusing with the white of the median space; t.a. indistinct from costal margin to median vein, with a strong outward bend at median vein, then broadly excurved to inner margin. Forewing of most specimens with an indistinct basal line, inwardly dark and outwardly pale, terminating at median vein. Basal space brownish-grey to olive-grey. Transverse posterior line white, commonly margined proximally by dark scaling, angling outward from costa for one third its length, bending abruptly inward, then broadly incurved to trailing margin. Median space white or pale yellow variably suffused with olive, grey, or olive-grey, occasionally heavily so. Orbicular small, evident above the bend of the t.a. line; in some specimens partially fused with basal area of wing. Reniform moderately small. Median space with brown or olive-brown costal band between orbicular and reniform. Commonly a small dark claviform beyond the t.a. line, occasionally absent. Subterminal line irregular, usually with two inwardly directed teeth, one opposite cell, the other near inner margin. Subterminal space narrow, concolorous with basal space, severely constricted or even severed opposite cell. Terminal space very pale inwardly, darkening somewhat toward margin of the wing but never as dark as s.t. space. A series of indistinct dark terminal lunules. Fringe concolorous with terminal space.

Hind wing white centrally, completely margined by broad, dark-brown band. Discal spot, large, dark brown, fusing anteriorly with costal marginal band.

Beneath, forewing white with faded grey-brown outer marginal band; dark-brown reniform, orbicular and basal dash. Fringe of forewing white with an admixture of brown scales. Underside of hind wing white with brown inner and outer marginal band and brown discal spot.

Expanse: 18.3 ± 1.2 mm. (21 specimens).

Foretibia (Fig. 6) provided with one long inner claw, and commonly two or three short outer spines. Abdominal brushes absent in male.

Male Genitalia (Fig. 24).—Valve moderately long and narrow, somewhat flattened. About 20 setae in corona, arranged in a long row at apex of valve. Ampulla reduced to a short flap. Juxta roughly shield-shaped, truncated dorsally and with broad lateral lobes ventrally. Uncus moderately stout. Vesica without basal diverticulum.

Female Genitalia (Figs. 41, 58).—Valve of ovipositor triangulate, tapering to a rounded point, with a moderate covering of short fine setae. Penultimate segment clothed with moderately coarse spicules. Fundus bursae with one or two moderately short signa.

Distribution (Fig. 135) *and Period of Flight.*—The species is confined to regions of southern California. Specimens examined were collected between March 17 and April 20.

Type Material.—There are a male and a female labelled "type" at the American Museum of Natural History. Both specimens were taken in the Argus Mts., Los Angeles Co., California. The male is badly scarred from spreading and the left valve of the genitalia is missing. For this reason, the female, which is in good condition, is here selected as lectotype. The forewing is dull olive-grey, with a pale-grey median area heavily suffused with olive-grey. The type expands 18.5 mm.

The species was described by Smith on the basis of three specimens. A female labelled "cotype" in the United States National Museum is presumably the third specimen of the trio.

Life History and Habits

The larvae of *Schinia triolata* feed on the blossoms of *Chaenactis freemontii* Gray. The gravid female alights head upward on the side of an unopened bud and inserts her ovipositor through the lateral wall of sepals to deposit her eggs among the florets. The moths are rapid and elusive fliers moving quickly from blossom to blossom while ovipositing.

The female from which eggs were obtained for rearing was taken at Whitewater Pass, Riverside County, California at an elevation of one thousand feet, which is the most southerly locality from which specimens have been examined. The species was not common in the area, and only two females and a few males were taken in several days collecting, although the hillsides were carpeted with the white blossoms of the food plant.

After emerging from the egg, the first-stadium larva bores immediately into a floret and feeds within. Second and third stadium larvae move among the florets and feed on their contents but do not enter the individual florets. Fourth and fifth stadium larvae eat both florets and seeds but they feed less extensively on seeds than do other members of the group that have been studied.

Immature Stages[7]

Egg (Fig. 74).—Smooth, except for some weak dimpling on anterior surface. Light greenish-yellow when deposited; assuming a stronger yellow tone on second day. On third day, anterior half of egg pinkish-orange. On fourth day posterior half of egg orange-yellow, anterior half pinkish-orange.

Cells of primary rosette usually regularly arranged. Cells of second series commonly elongate. Cells beyond second series quadrate, pentagonal or hexagonal. Cells well defined to fourth to seventh series. One or two series

[7]For details of larval anatomy, see "Structure of the Larva", page 28.

of evanescing cells visible beyond this. Pores moderately small, few; two or three series present beyond third to sixth series of cells. Mean diameter of primary rosette, .058 ± .006 mm.; mean number of primary cells, 13.9 ± 1.2 (19 eggs from 2 females).

A single female of *triolata* taken at Whitewater, Riverside Co., California, deposited a total of 41 eggs. These hatched in four days at room temperature.

Dimensions of egg: 0.70 ± 0.05 mm. x 0.44 ± 0.03 mm. (40 eggs from 2 females; Whitewater, Riverside Co., Calif.).

First-Stadium Larva.—Head, prothoracic and suranal shields dull black or dark blackish-brown. Trunk pale cream. Spiracles with dark-brown rims. Thoracic legs dark blackish-brown.

Head capsule width: 0.26 ± 0.01 mm. (17 larvae).

Duration of stadium: 2.8 ± 0.6 days (12 larvae).

Second-Stadium Larva.—Head black. Prothoracic and suranal shields dark blackish-brown. Trunk cream. Occasionally one or two pairs of pale lines on dorsum. Spiracles with dark-brown rims. Thoracic legs dark smoky-grey.

Head capsule width: 0.42 ± 0.02 mm. (17 larvae).

Duration of stadium: 2.3± 0.7 days (12 larvae).

Third-Stadium Larva.—Head orange-brown, variably suffused and mottled with somewhat darker brown. Prothoracic shield brown, variably suffused with dark brown, usually heavily so. Suranal shield fawn, mottled with dark brown. Trunk cream, often suffused with pale green. Two pairs of pale-cream longitudinal lines on dorsum. A pale-cream spiracular band. Spiracles with medium-brown rims. Thoracic legs dark smoky-grey.

Head capsule width: 0.67 ± 0.03 mm. (17 larvae).

Duration of stadium: 2.2 ± 0.6 days (12 larvae).

Fourth-Stadium Larva.—Head light orange-fawn, marked with medium chocolate-brown. Prothoracic shield greyish-green, lightly mottled with medium brown, usually with three cream longitudinal lines. Maculation and colouring of suranal shield not, or poorly distinguished from those of trunk.

Trunk yellowish-green to greyish-green. Mid-dorsal band the darkest green of body; margins rather irregular; often bisected by a discontinuous pale-yellow line. Subdorsal area yellowish-green, trisected by a pair of darker green longitudinal lines. Supraspiracular area darker green than subdorsal area, somewhat paler green than mid-dorsal band; irregularly marked with yellowish-green spots; often with a badly broken yellowish-green, median longitudinal line. Spiracular band yellowish-green, often bisected by a darker green longitudinal line. Spiracles with medium to dark-brown rims. Suprapodal area somewhat paler green than supraspiracular area; spotted with pale greenish-cream. Mid-ventral area greyish-green. Thoracic legs pale fawn, lightly marked with medium brown.

Head capsule width: 1.08 ± 0.06 mm. (13 larvae).

Duration of stadium: 3.3 ± 1.2 days (12 larvae).

Fifth-Stadium Larva (Fig. 179).—Head cream to light fawn, spotted with medium chocolate-brown. Two arcs, free of mottling, diverging upward and outward from centre of face. Prothoracic shield pale fawn variably suffused with green. Suranal shield poorly distinguished from trunk, green or greenish-fawn.

Trunk yellowish-green to greyish-green. Mid-dorsal band somewhat darker than other areas of body. Subdorsal area cream or white, with two irregular and

occasionally discontinuous, longitudinal green lines. Supraspiracular area somewhat lighter green than mid-dorsal band; with two or three irregular and broken longitudinal white lines. Spiracular band white with a narrow, irregular, and badly broken median longitudinal green line; the latter often degenerating into a linear series of small green spots. Spiracles with medium- to dark-brown rims. Suprapodal area concolorous with, or somewhat paler than supraspiracular area; marked with small, irregular, white spots. Mid-ventral area greyish-green. Thoracic legs green, or fawn suffused with green.

Head capsule width: 1.60 ± 0.05 mm. (5 larvae).

Duration of stadium: 3.3 ± 0.9 days (12 larvae).

Pupa (Figs. 125-127, 191).—Slender, lightly sclerotized; pale green, with white fat accumulations visible through cuticle. Mesothoracic legs terminating some distance anterior to apex of proboscis. Visible distal portions of metathoracic legs generally somewhat smaller than those of *villosa*. Seta L2 absent from surface of fourth abdominal segment. Fourth abdominal segment unpitted. Pits on abdominal segments five to seven more numerous than in *villosa*. Rims of spiracles low. Cremaster consisting of two slender, diverging, straight or weakly curved spines, longer than those of *villosa*.

Length to posterior margin of fourth abdominal segment: 6.7 ± 0.2 mm. (7 pupae).

SCHINIA VACCINIAE (HY. EDWARDS)

Fig. 153

1876. Hy. Edwards, Proc. Calif. Acad. Science 6: 134; *Melicleptria.*
1883. Smith, Trans. Am. Ent. Soc. 10: 251.
1893. Smith, Bull. U.S. Nat. Mus. 44: 289.
1903. Hampson, Cat. Lep. Phal. 4: 21; *Heliothis.*
1927. Draudt, Groszschmett. der Erde 7: 333; *Pseudotamila.*

vanella (Grote)

1879. Grote, Can. Ent. 11: 197; *Tamila.*
1883. Smith, Trans. Am. Ent. Soc. 10: 239; *Pseudotamila.*
1893. Smith, Bull. U.S. Nat. Mus. 44: 287.
1903. Hampson, Cat. Lep. Phal. 4: 27.
1913. Barnes & McDunnough, Contrib. Nat. Hist. Lep. N.A. 2(1): 10; sunk to *vacciniae.*

Forewing brown with white median area; hind wing dark brown with white central area.

Head and thorax clothed with greyish-brown vestiture. A dark-brown, transverse band on patagia of many specimens. Abdomen usually somewhat paler than thorax, brownish-grey. Beneath, head, thorax and abdomen whitish-grey.

Transverse anterior line of forewing broadly excurved, usually with two inwardly directed teeth. White of t.a. line commonly merging with white or cream of median space. Basal line forming an outwardly directed V between costal margin and median vein. Colour of wing proximal to basal line paler than rich dark brown of remainder of basal area. Transverse posterior line white, usually finely denticulate, commonly with a line of darker scaling proximally, separating it from median area; broadly excurved opposite cell, then with a slight inward slant to trailing margin. Median space white or cream; a diffuse brown median shade through median space, broadening to form a costal band between t.a. and t.p. lines. Reniform spot fairly large, brown, with pale central area, somewhat obscured by the brown median shade which passes through it. Subterminal line sinuate, often jagged, whitish. Subterminal space the rich dark brown of basal space, usually with some darker scaling along the veins. Terminal space paler than s.t. space, commonly with a series of dark

terminal dashes on the veins. Fringe concolorous with, or somewhat paler brown than terminal space and commonly checkered by groups of darker scales.

Hind wing with broad, brown, marginal band and rather restricted white central area. A dark-brown discal spot in white central area, usually fusing both anteriorly and posteriorly with marginal band. A short, narrow, white line in the brown outer marginal band. Fringe white.

Beneath, forewing with median and terminal areas white; basal and subterminal areas and reniform brown. Apex and costal margin of wing suffused with red. Fringe pale brown with some red scaling. Central and apical portion of hind wing white, the apical area suffused with red. Basal and inner areas of wing brown. A large discal spot in central white area of wing. Fringe of hind wing white.

Expanse: 20.2 ± 1.5 mm. (71 specimens).

Foretibia (Fig. 7) commonly with five or six inner spines and three or four outer spines. Abdominal brushes present in male.

Male Genitalia (Fig. 23).—Valve slender, tapering to a narrow apex. Corona consisting of about a dozen clumped setae. Ampulla short, stout. Uncus relatively stout, sausage-like. Juxta large, essentially quadrate, somewhat broader ventrally than dorsally. Vesica in some specimens with a suggestion of a basal diverticulum.

Female Genitalia (Figs. 42, 59).—Ovipositor valve triangulate, tapering to a rather sharp point, well clothed with minute setae. Penultimate segment covered with short broad spicules giving it a somewhat cobblestoned appearance. Fundus bursae provided with four elongate, well-defined signa.

Distribution (Fig. 143) *and Period of Flight.*—The species ranges from southern Washington south through the Cascades and Sierra Nevada to Monache Meadows, Tulare Co., California. The material examined was collected between July 23 and August 29.

Type Material.—The type of *vacciniae* was collected by H. Behr in the Sierra Nevada. Hy. Edwards records its deposition in the Behr collection which was destroyed by fire, and the specimen presumably no longer exists. Grote's type was collected in "Nevada" by E. L. Graef and now is in the collection of the British Museum (Natural History).

The life history of the species is unkown.

Immature Stages

Egg (Fig. 80).—Pattern greatly reduced. Cells of primary rosette regular in most cases. Secondaries well defined or evanescent and incomplete. Tertiaries evanescent or undefined. No cells visible beyond third series. Pores very large, abundant at outer angles of secondaries; fewer at outer angles of tertiaries. Occasional pore present at outer margins of primary cells. Mean diameter of primary rosette, .060 ± .004 mm.; mean number of primary cells, 13.2 ± 1.0 (13 eggs from 2 females).

Dimensions of Egg: .79 ± .07 mm. X .48 ± .03 mm. (44 eggs from 2 females; Oregon; Mt. Hood, Oreg.).

SCHINIA SUETA (GROTE)

1873. Grote, Bull. Buff. Soc. Nat. Sci. 1: 117; *Heliothis.*
1883. Smith, Trans. Am. Ent. Soc. 10: 245; *Melicleptria.*
1893. Smith, Bull. U.S. Nat. Mus. 44: 289.
1903. Hampson, Cat. Lep. Phal. 4: 21; *Heliothis.*
1903. Holland, Moth Book, p. 230; *Melicleptria.*
1927. Draudt, Groszschmett. der Erde 7: 332.

Forewing shades of green, red, purple or brown with creamy-white median space. Hind wing dark brown or black with two white central spots which may partially coalesce behind point of discal spot.

Head, thorax and abdomen with olive-grey vestiture above, and whitish-grey vestiture beneath.

Transverse anterior line excurved in general outline, but shortly incurved between the subcostal and median veins. T.a. line white or pale blue, often losing its identity mesally by fusing with white of median space. Immediate base of wing commonly with olive-grey scaling. In most specimens a poorly expressed pale basal line between costal and median veins. Transverse posterior line straight or shallowly excurved from costa to median vein, then sharply incurved to a point below the reniform, then straight or shallowly excurved to trailing margin. T.p. line white or pale blue often losing its identity to median space in its middle portion. Median space white or cream, broad anteriorly, narrow posteriorly. A band of dark scaling along costal margin of median space. Posterior constricted portion of median space largely filled with dark scaling. Reniform large, dark, fused anteriorly with costal band. Subterminal line irregular, mostly parallel to outer margin of wing but curving outward posteriorly to outer angle of wing. Subterminal space concolorous with basal area of wing. Terminal space usually much paler than s.t. and basal spaces. A weak, dark, terminal line. Fringe in most cases concolorous with terminal space, variably flecked with darker scaling.

Hind wing dark brown or black, with white fringe. A diffuse white patch in middle of costal margin. Two white spots in middle of hind wing, the anterior rounded, the posterior quadrate. In some instances, the two spots partially fusing around posterior point of discal spot by which they are separated.

Beneath, wings pale grey apically and white centrally; basal and inner areas of wings dark brown. Reniform spot of forewing large, dark brown. Median space margined outwardly by a brown submarginal band, narrow anteriorly, broad posteriorly. Hind wing with dark-brown patch at base, a narrow brown inner marginal band and a large dark patch at outer angle of wing. A large dark discal spot in the middle of wing. Fringes of both fore- and hind wings pale whitish-grey.

Foretibia (Fig. 1) averaging four elongate, slender, outer and four inner spines. Abdominal brushes present in male.

Male genitalia (Fig. 25).—Valve elongate, relatively broad and stout. About a dozen setae in corona, arranged largely in a single row along apical margin of valve. Ampulla elongate, slender. Juxta generally with lateral points and with dorsal margin broadly pointed. Vesica without basal diverticulum.

Female Genitalia (Figs. 44, 61).—Ovipositor elongate. Valve varying considerably in width. Dorsal margin of valve essentially straight, ventral margin broadly rounded; apex sharply rounded. Valve with a heavy clothing of minute setae, and a number of elongate slender ones. Penultimate segment with a dense clothing of fine spicules. Many specimens with four elongate signa; others showing reduction in size and number.

Distribution (Fig. 136) *and Period of Flight.—Sueta* is widely distributed in western North America, occurring in many regions between the Rocky Mountains and the Pacific. The moth flies between the first part of April and the end of August, depending on latitude and altitude.

The species segregates into five definable geographic subspecies which do not exhibit any corollary variation in the structure of the male and female genitalia.

Schinia sueta sueta (Grote)

Fig. 154

The ground colour of the forewing in the nominate subspecies ranges from a greenish-lavender through light mauve to pale reddish-brown.

Expanse: 24.3 ± 2.0 mm. (66 specimens).

Distribution and Period of Flight.—The nominate race of *sueta* occurs in the Southern Rocky Mountains of Colorado. Material examined was collected in May, June and July.

Type Material.—The type of *sueta* is a male in the collection of the Michigan State College at East Lansing. It is in generally fair condition although both antennae are broken and the hind wings have been badly perforated in spreading. The ground colour of the type is olive-orange. The specimen, taken in "Colorado Territory", expands 24 mm.

Schinia sueta californica (Grote)

Fig. 155

1873. Grote, Bull. Buff. Soc. Nat. Sci. 1: 149; *Heliothis.*
1883. Smith, Trans. Am. Ent. Soc. 10: 245; *Melicleptria;* sunk to *sueta.*
1917. Barnes & McDunnough, Check List, p. 37; considered a race of *sueta.*
1927. Draudt, Groszschmett. der Erde 7: 332.

Californica is the most variable, both as to size and colouring, of the subspecies here considered. It is larger and generally more deeply coloured than the nominate subspecies. The forewing ranges from a rich amber-green through various shades of red to dark brassy-brown. A dark-red form seems to predominate. Specimens from southern California are smaller and paler than those from more northerly localities.

Expanse: 27.4 ± 2.2 mm. (108 specimens).

Distribution and Period of Flight.—Californica inhabits the coast ranges of California and marginally at least the western Mojave Desert. It is distributed from San Diego in the south to Preston, Sonoma County in the north. Only a single specimen from Bakersfield indicates the presence of the subspecies in the San Joaquin Valley. The majority of specimens of *californica* examined were taken in April and May.

Type Material.—Californica was described from four specimens taken by Henry Edwards in Alameda Co., California. Of these there is a male in the collection of the Michigan State College at East Lansing and a male in the British Museum (Natural History). The specimen at East Lansing is blackish, with the genitalia shattered and telescoped within the abdomen and with left antenna broken. It expands 24 mm. Because of the generally poor condition of this specimen, the male in the British Museum is here selected lectotype. There are three specimens, all in good condition, from the type lot (Hy. Edwards No. 93) in the American Museum of Natural History.

Schinia sueta sierrae new subspecies

Fig. 156

At higher altitudes in the Sierra Nevada of California there occurs a subspecies of *sueta* that is distinguished by its small size, which is close to that of the nominate subspecies, and its intensive and wide range of colouring, which approximates that of *sueta californica.* As in *sueta californica,* there seems to be a tendency for the colouring of the subspecies to become more dilute in the southern part of its range. The most intensely coloured individuals examined were those taken on Mt. Lassen.

Expanse: 24.3 ± 1.5 mm. (24 specimens).

Distribution and Period of Flight.—The subspecies is distributed from Bishop Creek, Inyo Co., in the south to Mt. Lassen in the north. Specimens examined were taken between June 20 and August 28.

Type Material.—Holotype female: Lassen Pk., 7,500 ft., Shasta Co., Calif., July 18, 1949. Allotype male: Round Valley, Inyo Co., Calif., July 15, 1922. Paratypes, seven females, five males: Mt. Lassen, July 22, 1944 (B. Weber); Sonora Pass, Tuolumne Co., 9,623 ft., July 24, 1953 (T. W. Davies); Minaret Summit, Mono Co., July 19, 1936 (C. W. Kirkwood); Camp High Sierra, Mammoth Lakes, Mono Co., July 19, 1944 (Rudy Mattoni); N.E. of Duck Lake, Mammoth Lakes, Mono Co., July 24, 1944 (Rudy Mattoni); between Clark and Agnew Lake, Mono Co., August 15, 1944; Mammoth, July 8, 1933 (G. & R. Bohart); Round Valley, July 15, 1922; Bishop Creek, Inyo Co., 8,100 ft., June 20, 1950 (L. M. Martin).

The holotype and allotype are in the Canadian National Collection (Type No. 6283). Paratypes are deposited in the collections of the Los Angeles County Museum and the University of California. The holotype, expanding 25 mm., is brownish-olive. The allotype expanding 22 mm., is pinkish-grey. The white areas of both fore- and hind wings are more extensive in the allotype than in the holotype.

Schinia sueta martini new subspecies

Fig. 157

The northwestern subspecies of *sueta* is distinguished by the almost complete absence of all colour phases except green. It was first thought that moths belonging to northwestern populations were exclusively green. In the summer of 1953, however, four pale pink specimens in a total series of 63 specimens were taken in the southern Okanagan Valley of British Columbia. All other material that was examined from the Pacific Northwest and from British Columbia was green. The subspecies is somewhat smaller in size than is *sueta californica.*

Expanse: 26.1 ± 2.0 mm. (101 specimens).

Distribution and Period of Flight.—In British Columbia the subspecies has been taken only in the southern portion of the interior Plateau. In the west it ranges south to Crater Lake, Oregon, and in the east, south along the Rocky Mountain system through western Montana to Yellowstone Park, Wyoming. A presumably isolated population of the subspecies occurs in the Sweetgrass Hills of northern Montana. The material examined was taken between the middle of May and the middle of August, depending largely upon the altitude at which the specimens were taken.

Type Material.—Holotype male, allotype female: 6 miles south Vernon, B.C., 1,400 feet, May 29, 1953 (J. E. H. Martin). Paratypes, 29 males, 35 females: 6 miles south Vernon, B.C., 1,400 feet, May 29, 1953 (D. F. Hardwick, J. E. H. Martin); 5 miles north Osoyoos, B.C., 1,200 feet, May 21 to June 6, 1953, (D. F. Hardwick, J. E. H. Martin); Osoyoos, B.C., 2,500 feet, June 25, 1953 (J. E. H. Martin); Osoyoos, B.C., 3,500 feet, July 1 to July 6, 1953 (D. F. Hardwick, J. E. H. Martin, J. R. McGillis); Osoyoos, B.C., 4,000 feet, July 15, 1953 (J. E. H. Martin).

The type material is in the Canadian National Collection (Type No. 6278). The holotype expands 26.5 mm.; the allotype 29 mm. The cream and white areas of both fore- and hind wings of the holotype are much less extensive than those of the allotype. Four of the paratype are of the pink colour phase; the remainder of the type series is of the predominant green colouring.

I take pleasure in naming this subspecies after the enthusiastic collector who has so materially aided me in the field.

***Schinia sueta aetheria* (Barnes & McDunnough)**

Fig. 158

1912. Barnes & McDunnough, Can. Ent. 44: 17; *Heliothis*.
1912. Barnes & McDunnough, Contrib. Nat. Hist. Lep. N.A. 1 (4): 40.
1927. Draudt, Groszschmett. der Erde 7: 332.

Aetheria may possibly represent a species distinct from *sueta* but it is apparently the geographic representative of the latter. For the present, in the absence of any discernible morphological difference, it seems preferable to consider it a subspecies of *sueta*.

In size and colouring *s. aetheria* closely resembles the nominate subspecies. It differs chiefly in the more extensive areas of white or yellow in both fore- and hind wings. The ground colour of the forewing varies from a rich red through reddish-mauve to dark chocolate. The t.a. line is pale blue rather than white as in other subspecies. The basal area of the forewing of some specimens has an irregular subcostal blue line passing through it from the base to the t.a. line, and the median yellow or white area is usually more extensive. The white spots of the hind wing are also larger in *aetheria*, often coalescing behind the point of the discal spot.

Expanse: 25.8 ± 1.8 mm. (25 specimens).

Distribution and Period of Flight.—The great bulk of the material examined was taken at Redington, Arizona, but I have examined one specimen taken on Mt. Pilot in the Sierra La Sal of southeastern Utah, which has the blue shading and extensive white areas of both fore- and hind wings which is typical of *s. aetheria*. This specimen suggests that the subspecies extends northward into the vast, poorly collected areas of the Colorado Plateau. The Redington material is without date of collection. The Mt. Pilot specimen was taken on July 11.

Type Material.—There are a male and a female specimens, labelled type, in the United States National Museum. They were taken at Redington, Arizona. Both are in good condition although the female lacks the left antenna. The male specimen, which is rich dark red with yellow median area, is here selected as lectotype. It expands 25 mm.

Discussion

Extensive collection of material and investigation of local situations in the Colorado Plateau of Utah and northern Arizona will be necessary to establish the status of populations in this area. The majority of the rather limited material examined from the region agrees in general features with the nominate subspecies but, as previously mentioned, the single specimen examined from the Sierra La Sal has the distinctive blue shading that has been associated with Arizona *s. aetheria*.

Life History and Habits

Females of *Schinia sueta californica* from which eggs were obtained for rearing were taken in Marin Co., California, about seven miles southwest of Petaluma. The moths were depositing their eggs in the heads of *Lupinus nanus* Dougl.

In the Okanagan Valley from Vernon south to Osoyoos, the larva of *sueta martini* feeds on *Lupinus sericeus* Pursh. At an elevation of about 1,000 feet on the valley floor, the adults fly in the last two weeks of May. As the season advances and lupine blooms farther up the slopes, the subspecies flies progressively later. In early July, it may be found on the benchland above Osoyoos at

an altitude of about 4,000 feet. At this altitude the moth deposits its eggs in the heads of *Lupinus leucopsis* Agardb.

While the maculation and colouring of *sueta* does not appear to be particularly adaptive, the green and white or red and white of the moth blends well with the lupine heads on which it rests. Moths sitting on the unopened buds or nestled between the blossoms are not readily detected.

The eggs are laid between the small buds at the terminus of the growing shoot and beneath the sepals of the larger buds and open blossoms. The majority of the eggs are deposited beneath the upper sepals. Occasionally eggs are inserted within the blossom against the developing seed pod.

When the larvae hatch they commonly feed first on the orange anthers of the lupine blossoms. They subsequently make their way to the base of the blossom and feed on the soft tissues of the diminutive seed pod.

In the intermediate stadia, the larvae generally attack the larger pods. They tunnel into the side and after gaining entrance seal the hole with silk. An injured pod is thus difficult to detect. The seeds and fleshy inner tissues of the pod are consumed by the larva. During the period in which the larva is confined within, the pod often dries and becomes hard and tough. On several occasions observed the larva was only released from its containing seed pod when the latter dehisced.

In the last stadium, the larva makes no attempt to hide itself within the pod but feeds on its contents from outside. It presumably hides during the daytime in the debris at the base of the plant.

Immature Stages[8]

Egg (Fig. 83).—Surface of anterior two-thirds weakly to strongly corrugated; remainder smooth. Pale yellow-green when laid, colouring first to yellow, then orange and then brown; becoming deep greyish-brown a few hours before hatching.

Reticular pattern very variable. Cells of primary rosette regularly arranged in most cases. Secondary cells usually elongate. Tertiary cells commonly shorter and broader. Cells of third and fourth series becoming arranged in regular columns. Cell walls generally evanescent beyond third or fourth series. In some instances, however, columnar walls (ribs) visible for several series of cells beyond fourth series. Pores varying greatly in prominence, usually of medium size. Pores commonly present from outer angles of cells of third series to cells of eighth to twelfth series. Mean diameter of primary rosette for *sueta californica*, .071 ± .007 mm.; mean number of primary cells, 16.1 ± 1.7 (38 eggs from 5 females). Mean diameter of primary rosette for *sueta martini*, .068 ± .004 mm.; mean number of primary cells, 15.9 ± 1.9 (25 eggs from 3 females). Mean diameter of primary rosette for *sueta sierrae*, .079 ± .006 mm.; mean number of primary cells, 14.5 ± 1.7 (32 eggs from 2 females).

Five females of *sueta martini*, taken at Osoyoos, B.C., deposited a total of 738 eggs in captivity, the maximum per female being 356 eggs. These hatched in four to six days at room temperature.

Dimensions of egg: *Schinia sueta californica*, .76 ± .04 mm. X .55 ± .04 mm. (41 eggs from 5 females; Mint Canyon, Los Angeles Co., Calif.; Marin Co., Calif.). *Schinia sueta martini*, .69 ± .04 mm. X .49 ± .02 mm. (115 eggs from 4 females; Osoyoos and Vernon, B.C.). *Schinia sueta sierrae*, .76 ± .05 mm. X .52 ± .03 mm. (60 eggs from 2 females; Lassen Peak, Shasta Co., Calif., 7,500 ft.; Round Valley, Inyo Co., Calif.).

[8]For details of larval anatomy, see "Structure of the Larva", page 28.

First-Stadium Larva.—Head deep blackish-brown. Prothoracic and suranal shields medium brown. Trunk yellowish-grey becoming stained deep orange as a result of larva feeding on lupin anthers; somewhat paler ventrally than dorsally. Spiracles with medium-brown rims. Thoracic legs yellow-fawn.

Head capsule width: *Schinia sueta californica*, 0.32 ± 0.01 mm. (42 larvae). *Schinia sueta martini*, 0.31 ± 0.01 mm. (50 larvae).

Duration of stadium: *Schinia sueta californica*, 4.8 ± 1.3 days (20 larvae). *Schinia sueta martini*, 4.2 ± 1.7 days (22 larvae).

Second-Stadium Larva.—Head dark brown. Prothoracic and suranal shields medium orange-brown, variably suffused with darker brown, usually heavily so. Dorsum greyish-green, often stained orange as in first instar; one or two pairs of evanescent yellowish-grey subdorsal lines usually present. Spiracular band expressed in some specimens as a pale-grey shade. Spiracles with medium-brown rims. Ventral area somewhat paler than dorsal area. Thoracic legs yellow-fawn.

Head capsule width: *Schinia sueta californica*, 0.53 ± 0.03 mm. (43 larvae). *Schinia sueta martini*, 0.48 ± 0.03 mm. (50 larvae).

Duration of stadium: *Schinia sueta californica*, 2.4 ± 0.5 days (20 larvae). *Schinia sueta martini*, 2.6 ± 0.4 days (22 larvae).

Third-Stadium Larva.—Head orange-brown variably suffused and mottled with dark brown; heavily mottled head capsules often with a pair of pale arcs diverging from centre of face to posterior margin of head capsule. Prothoracic shield orange-brown, variably suffused with dark brown; a pale-yellow mid-dorsal shade usually present; submarginal longitudinal pale-yellow shades also occasionally present. Suranal shield yellow or orange variably suffused with brown.

Dorsum varying from deep slate-grey through shades of greenish-grey to dull yellowish-grey. Two pair of evanescent yellowish-grey longitudinal lines, demarking the margins of the subdorsal area, on trunk of most specimens; in some specimens only the more dorsal pair of these evident. Median portion of subdorsal area somewhat paler than middorsal area. Supraspiracular area concolorous with median portion of subdorsal area. Spiracles with medium- to dark-brown rims. Spiracular band expressed in some specimens as a narrow yellowish-grey band; in other specimens indistinguishable from supraspiracular and suprapodal areas. Suprapodal and mid-ventral areas usually somewhat paler than dorsal region of trunk. Thoracic legs yellow-orange to medium brown.

Head capsule width: *Schinia sueta californica*, 0.88 ± 0.07 mm. (43 larvae). *Schinia sueta martini*, 0.78 ± 0.05 mm. (50 larvae).

Duration of stadium: *Schinia sueta californica*, 2.8 ± 0.6 days (20 larvae). *Schinia sueta martini*, 2.9 ± 1.3 days (22 larvae).

Fourth-Stadium Larva.—Head light to medium orange-brown; in many cases heavily suffused with darker brown; dorsal half of head capsule of paler specimens often mottled with darker orange-brown spots and patches; pale arcs usually evident in mottled specimens, diverging from centre of face to posterior margin of head capsule. Prothoracic shield yellow, orange or fawn, variably suffused with dark brown, often heavily so; in deeply suffused specimens, pale longitudinal mid-dorsal and submarginal shades or lines generally evident. Suranal shield yellow to orange-brown, variably suffused with dark brown; usually three pale longitudinal shades evident, when heavily suffused.

Mid-dorsal band of trunk yellow-green to greyish-olive-green; partially bisected on meso- and meta-thorax by a discontinuous pale-yellow mid-dorsal

line. Subdorsal area consisting of a median green band, somewhat paler than the mid-dorsal band, and dirty-yellow marginal lines of which the dorsal is the more prominent and consistently present. Supraspiracular area concolorous with median band of subdorsal area. Spiracles with dark-brown rims. Spiracular band narrow, dirty yellow. Suprapodal area somewhat paler than supraspiracular area with a dirty-yellow, weak, discontinuous, median longitudinal line. Mid-ventral area pale dirty-grey. Thoracic legs orange-brown, variably suffused with darker brown.

Head capsule width: *Schinia sueta californica*, 1.47 ± 0.06 mm. (46 larvae). *Schinia sueta martini*, 1.22 ± 0.06 mm. (50 larvae).

Duration of Stadium: *Schinia sueta californica*, 3.5 ± 1.1 days (20 larvae). *Schinia sueta martini*, 5.3 ± 1.9 days (22 larvae).

Fifth-Stadium Larva (Figs. 180-182).—Head yellow-fawn or orange; variably suffused with dark brown, in dark specimens heavily so; dorsal portion of head capsule of paler specimens mottled with orange-brown; pale arcs diverging from centre of face to posterior margin of head capsule often evident. Prothoracic shield yellow-fawn or orange variably suffused with dark brown; commonly median and submarginal longitudinal yellow or orange shades in darkly suffused specimens. Suranal shield pale yellow to orange, variably suffused with dark brown; commonly three pale longitudinal lines evident in darkly suffused specimens.

Mid-dorsal band of trunk varying from pale fawn-grey, through greenish-grey to dark blackish-grey; bisected on meso- and meta-thorax by a pale-fawn or yellow median line. Subdorsal area consisting of pale-fawn or grey marginal lines, of which the dorsal is the more prominent, and a median band similar in colour to, but paler than the mid-dorsal band. Supraspiracular area concolorous with or somewhat darker than median band of subdorsal area; supraspiracular area often with some paler flecking. Spiracles with dark-brown rims. Spiracular band yellowish-white, well defined in dark specimens, poorly distinguished from supraspiracular and suprapodal areas in pale specimens. Suprapodal area yellowish-grey to medium grey with a broken longitudinal line evident in darker specimens. Mid-ventral area creamish-grey. Thoracic legs yellow or orange, variably suffused with dark brown.

The dorsum of the trunk of *S. sueta* is often flushed with pink or mauve. The tones of colouring of *sueta californica* tend generally to darker shades than those of *sueta martini*. No reared specimens of the latter were of the intense black-brown of some specimens of *californica*. Similarly, no specimens of *californica* were reared that were so pale as the paler specimens of *martini*. A large proportion of ultimate-stadium larvae of *martini* was of a greenish-grey tone not commonly found among reared *californica* larvae.

Head capsule width: *Schinia sueta californica*, 2.58 ± 0.13 mm. (11 larvae). *Schinia sueta martini*, 2.00 ± 0.10 mm. (21 larvae).

Duration of stadium: *Schinia sueta californica*, 5.3 ± 1.6 days (20 larvae). *Schinia sueta martini*, 6.7 ± 1.4 days (22 larvae).

Pupa (Figs. 108-113, 192).—Relatively stout, heavily sclerotized. Mesothoracic legs about the same relative length of those of *villosa*. Seta L2 present on surface of fourth abdominal segment near outer margin of wing. Fine punctations on dorsal surface of abdominal segments one to three. Somewhat larger punctations on fourth abdominal. Anterior two-thirds of abdominal segments five to seven heavily pitted. Much of posterior thirds of these segments punc-

tate. Cremaster consisting of four, elongate, straight or weakly curved spines, the median pair being somewhat longer.

Length to posterior margin of fourth abdominal segment: *Schinia sueta californica*, 9.3 ± 0.5 mm. (18 pupae). *Schinia sueta martini*, 8.7 ± 0.5 mm. (70 pupae).

SCHINIA AURANTIACA (HY. EDWARDS)

1881. Hy. Edwards, Papilio 1: 23; *Annaphila.*
1893. Smith, Bull. U.S. Nat. Mus. 44: 297; considered a heliothidine.
1895. Grote, Abh. Nat. Ver. Brem. 14: 111; *Incita.*
1927. Draudt, Groszschmett. der Erde 7: 333.
1950. Evans, Pan-Pac. Ent. 26: 21; life history described.

californica Hampson
1903. Hampson, Cat. Lep. Phal. 4: 25; *Pyrocleptria.*
1907. Smith, J. N.Y. Ent. Soc. 15: 141; sunk to *aurantiaca.*

Maculation complex. Forewing varying from dark chocolate-brown through fawn to pale yellow-brown. Hind wing orange to pale yellow with brown marginal band and discal spot.

Body vestiture varying from a dull grey-brown in pale individuals to a dull fawn-grey in dark individuals. Beneath, vestiture usually somewhat paler than above.

Transverse anterior line white or pale yellow, margined outwardly and inwardly with lines of brown scaling, the proximal line being the darker. T.a. line consisting of three outward arcs, the middle one being the largest and most prominent. An inconspicuous pale-grey basal line often discernible between costal and median veins, especially in dark specimens. Brown of basal space in darker specimens usually flecked with paler scaling. Tranverse posterior line white or pale yellow, margined inwardly and outwardly with lines of dark scaling. T.p. line strongly excurved between costal margin of wing and a point below the reniform, then essentially straight to the trailing margin. Median space pale yellow, paler than basal space, often heavily suffused with brown scaling, especially along costal and trailing margins. Orbicular and reniform brown, closely associated in median space; reniform considerably darker than orbicular. Orbicular commonly ringed or partially ringed by line of dark-brown scaling. In most specimens a small, dark claviform evident distal to the middle arc of the t.a. line. Commonly a brown median line evident from reniform to trailing margin. Subterminal line discernible as a grey, diffuse shade, or marked only by colour change; irregular, commonly with two inwardly directed teeth, one opposite cell and the other near trailing margin of wing. Subterminal space concolorous with basal space. Terminal space usually considerably paler than s.t. space. A series of dark, intervenal terminal lunules. Fringe concolorous with terminal space.

Hind wing orange to pale yellow. A varying amount of brown scaling at the base of wing, particularly heavy in darkly pigmented specimens. Width of marginal brown band, and size of discal spot varying considerably, darker specimens commonly with larger spots and wider bands. Fringe brown inwardly, pale yellow or white outwardly.

Beneath, forewing yellow with a broad brown border. Orbicular and reniform brown or black. The distal half of a basal dash present in most specimens. Fringe brown. Hind wing yellow with maculation as in obverse. Fringes inwardly brown, outwardly white.

Foretibia (Fig. 11) armed with long inner terminal claw and single smaller

outer spine. Mid and hind tibiae each provided with single apical spine. Tibial spining evidently consistent for species. Abdominal brushes not present in male.

Male Genitalia (Fig. 26).—Valve moderately short and broad, flattened. Corona consisting of about a dozen slender setae, mostly grouped in a single row along apical margin of valve. Ampulla of intermediate length. Uncus elongate, in some cases slightly dilated subapically. Juxta weakly sclerotized, somewhat variable in shape, usually with a slightly rounded dorsal margin. Vesica without basal diverticulum.

Female Genitalia (Figs. 45, 62).—Valve of ovipositor elongate, slender, rounded terminally. A weak covering of short, fine setae and a few elongate, slender ones, epecially along anterior margin of valve. Penultimate segment with a clothing of very short, fine spicules. Fundus bursae with two elongate, diametrically opposed signa in all specimens examined.

Distribution (Fig. 140) *and Period of Flight.*—The species occurs in central and southern California and in Arizona. Specimens examined were collected between late March and early June.

Two subspecies of *aurantiaca* have been described, the nominate subspecies from California and *aurantiaca tenuimargo* from Arizona.

Schinia aurantiaca aurantiaca (Hy. Edwards)

Figs. 159, 160

The nominate subspecies varies considerably in maculation and colouring. In Southern California specimens from coastal areas are commonly darker than those from the more arid interior. The interior specimens occupy a somewhat intermediate position in respect to colour intensity between coastal populations of *aurantiaca aurantiaca* and *aurantiaca tenuimargo*. Paler specimens commonly have smaller discal spots and narrower marginal bands than dark specimens.

Expanse: 17.3 ± 1.1 mm. (54 specimens).

Distribution and Period of Flight.—The subspecies ranges from San Diego in the south, east to Randsburg in the Mojave Desert, and northward, presumably through the inner coast ranges, to the Geysers in Sonoma Co., Calif. Specimens examined were taken between March 27 and June 9.

Type Material.—The type of *aurantiaca*, taken at the Geysers, is in the American Museum of Natural History. Contrary to the original description the specimen is a female. It expands 20 mm. The forewings are medium brown and the hind wings are orange with a narrow, brown marginal band. Hampson's type of *californica*, a male, also expanding 20 mm., was taken by Lord Walsingham in California, possibly also at the Geysers. It is in the British Museum.

Schinia aurantiaca tenuimargo (Barnes & McDunnough)

Fig. 161

1913. Barnes & McDunnough, Contrib. Nat. Hist. Lep. N.A. 2(3): 105; *Incita;* described as a race of *aurantiaca.*

1927. Draudt, Groszschmett. der Erde 7: 333.

The subspecies is distinguished by its overall pallid appearance in comparison with the nominate subspecies. The orbicular and reniform are much more striking in the pale background of the forewing. The marginal band of the hind wing is very narrow and the discal spot is greatly reduced. The basal dash on the underside of the forewing is very poorly expressed or absent. Although pale forms are found in California, none examined were so faded as the limited series of specimens of *tenuimargo* studied.

Expanse: 18.0 ± 1.0 mm. (6 specimens).

Distribution and Period of Flight.—The subspecies has been taken only at Redington, Arizona. Specimens examined were without information on date of flight.

Type Material.—There are a male and a female labelled type in the United States National Museum. Except for being thoracically "scalped", the female is in excellent condition. The male is without antennae and the left hind wing has a bad split at the apex. Both specimens were taken at Redington, Arizona. Because of its superior condition, the female is here selected as lectotype.

Life History and Habits

Evan's discussion (1950) of the life history is reproduced here:

"In the Gavilan Hills of Riverside County, California, on April 19, 1948, I observed several females of this species laying eggs between the hair entangled terminal bracts of young plants of *Gilia virgata* var. *dasyantha* (Brand.). Each moth required from 8 to 16 seconds to force its ovipositor through the dense woolly hairs and attach an egg near the base of a bract.

"In the breeding cage, the eggs hatched on May 8 and 9; and the tiny larvae entered the *Gilia* buds. During the early instars the larvae remained hidden inside the buds and fed on the partially developed floral parts; during the last three instars they rested on the stems and ate blossoms and woolly hairs of the food plant. Leaves and stems were never eaten. In their last instar, I substituted flowers of *Gilia densifolia* Benth., which they readily accepted. Larvae enter the soil to pupate. A brief description of the mature larvae follows:

"Length 20 mm. Ground colour greenish-white. A prominent mid-dorsal brown stripe extends from the second segment to the anal extremity. The following brown markings extend the entire length of the body; a subdorsal stripe which is rather indistinct on all but the first four segments; an irregular dorso-lateral stripe consisting of two fine, confluent lines; a rather dim lateral stripe; and a distinct supropodal stripe. There are a few brown markings on the prolegs. In the dorso-lateral area of each segment from 3 to 10 inclusive, there is a conspicuous rounded black spot a little forward of the center of the segment. The black spots on opposite sides of each of these segments are connected by a transparent orange bar which extends across the dorsal area. One larva lacked black spots on the third segment."

Immature Stages

Egg (Fig. 79).—Cells of primary rosette usually fairly regular. Secondary cells commonly elongate and apically rounded. Cells beyond second series quadrate, pentagonal or hexagonal. Cells becoming arranged in more or less regular rows radiating from micropyle in fourth or fifth series. Cells visible to sixth to eighth series, well defined to fourth to seventh series. Pores small, inconspicuous, few; two or three series commencing at outer angles of cells from fourth to sixth series. Mean diameter of primary rosette, 0.054 ± 0.007 mm.; mean number of primary cells, 14.1 ± 1.3 (60 eggs from 4 females).

Dimensions of Egg: 0.52 ± 0.04 mm. X 0.40 ± 0.03 mm. (60 eggs from 4 females; Red Mountain, San Bernardino Co., Calif.).

SCHINIA INDIANA (SMITH)

Fig. 162

1908. Kwiat, Ent. News 19: 423; *Heliolonche*.
1913. Barnes & McDunnough, Contrib. Nat. Hist. Lep. N.A. 2(1): 12.
1927. Draudt, Groszschmett. der Erde 7: 330.
1954. Forbes, Lep. N.Y., part 3, p. 19.

Forewing rich purplish-red, almost immaculate; hind wing dark chocolate-brown.

Head and thorax with dark-brown and grey vestiture. Abdomen dark brown with pale annuli at termini of segments and with a pale anal tuft. Beneath, head, thorax and abdomen dirty grey.

Forewing without definite lines, the regions of wing marked only by colour change. Transverse anterior line commonly broadly excurved throughout its length. Transverse posterior line excurved anteriorly, angling toward base posteriorly. Basal and subterminal areas rich wine-red. Median and terminal areas lavender variably suffused with red; terminal area usually somewhat paler than median area. A brown terminal line. Fringe whitish-grey. A suggestion of a dark reniform spot in median area. Macular bands of wing varying considerably in comparative breadth.

Hind wing deep chocolate-brown with pale whitish-grey fringe. A suggestion of a darker discal spot.

Beneath, forewing predominantly chocolate-brown, but with wine-red apical area. Reniform indicated as a darker-brown spot in the central brown area. A narrow, dirty-yellow, inner marginal band. Apico-costal half of hind wing wine-red. Posterior and inner half of wing chocolate-brown. A dark-brown discal spot protruding forward from dark area of wing into reddish portion. Fringes of both wings whitish-grey. Areas of red and brown of both wings varying considerably in extent.

Expanse: 16.7 ± 1.3 mm. (45 specimens).

Foretibia (Fig. 12) commonly armed with two or three inner and a similar number of outer spines. Male without abdominal brushes.

Male Genitalia (Fig. 27).—Valve relatively short and broad, flattened. Corona consisting of about 12, closely grouped setae. Ampulla very short. Juxta broadly rounded ventrally; dorsal margin produced to form a long, rounded peak. A rounded median ridge on surface of juxta in many specimens. Vesica without basal diverticulum.

Female Genitalia (Figs. 46, 63).—Valve of ovipositor short, blunt, broadly rounded, with a moderate covering of short fine setae and a number of longer setae. Intersegmental membrane proximal to valve with triangulate, heavily spiculated, leathery area ventrally. Penultimate segment clothed with fine spicules. Usually only one, weakly expressed, elongate signum on fundus bursae.

Distribution and Period of Flight.—The species has been recorded only from the vicinity of Chicago, Ill. Specimens examined were collected between May 27 and June 17.

Type Material.—There are two specimens at the American Museum of Natural History labelled "type"; the one, a male, was taken May 30, 1908 and the other, a female, was taken June 13, 1908. Both specimens were collected by Mr. A. K. Wyatt at Hessville, Ind. The male specimen, which is in superior condition, is here selected as lectotype. The type expands 17.5 mm. In addition to the specimens marked "type", there are a pair of "cotypes" at the American Museum and a number of "cotypes" at the United States National Museum.

Life History and Habits

The larvae of *indiana* feed on the seeds of *Phlox pilosa* L. The adults of the species are very inactive little moths evidently resting the greater part of the day on or among the blossoms of the food plant. The reddish-purple fore-

wings are usually darker than the fresh blossoms on which they rest. They much more closely resemble the colour of a partially dried corolla which is about to drop from the plant.

The eggs are deposited on the inner surfaces of the sepals next to the corolla tube. If the corolla drops before eclosion, the egg remains on the inner surface of the sepal and the hatching larva is in close proximity to the developing seed capsule. Less commonly the eggs are deposited between the small buds at the apex of the growing shoot.

Moths from which eggs were obtained, were taken at the type locality in Hessville (Hammond), Indiana. The larvae were reared at Ottawa, Ontario and the majority of them were fed on *Phlox divaricata* L., which they readily accepted.

On hatching, the young larva immediately attacks the bud or boll. If the egg has been laid under the sepal of an open blossom and the corolla has not dropped by hatching time, the young larva penetrates the corolla tube to reach the seed capsule. Those larvae entering closed buds may feed sparingly on the pollen but soon reach and attack the boll. Occasionally a young larva may enter the stem below a bud, or blossom and tunnel up through it to gain entrance to the developing seed capsule.

Third-stadium larvae commonly feed on the contents of the larger seed capsules by boring into them at their bases. Once a larva has penetrated the shell of the boll, the entrance hole is sealed with silk. The grey translucency of the silk almost exactly matches that of the lateral portions of the sepals. When the boll is first attacked, it is difficult to distinguish from a normal healthy boll. By the time that the contents have been consumed, however, the capsule has discoloured and become very hard. The larva evidently does not obtain release until the capsule dehisces.

In the fourth and fifth stadium, the larvae make no attempt to conceal themselves within the boll. They cling to the stem beneath the seed capsule, attack the latter at its base and eat out its contents. When the seeds have been consumed, the larva usually cuts the stem about an eighth inch below the boll so that the latter topples and hangs from the stem or drops to the ground.

Immature Stages[9]

Egg (Fig. 78).—Surface of anterior two-thirds of chorion corrugated, generally strongly so. Yellow when deposited, but anterior or micropylar half becoming orange within a day. By second or third day anterior half reddish-orange. On the day of hatching, anterior half deep reddish-orange; remainder pale yellow-orange.

Cells of primary rosette irregularly arranged in most cases. Secondary and tertiary cells well defined. Beyond third series, cells quadrate, arranged in regular columns. Longitudinal walls (ribs) of columnar cells variably expressed, often defined for considerable distance from micropylar area. Cross walls of columnar cells poorly or not expressed. Pores small, often difficult to discern; commonly present from fourth to seventh, eighth or ninth series of cells. Mean diameter of primary rosette, .063 $\pm$ .005 mm.; mean number of primary cells, 13.2 $\pm$ 1.8 (26 eggs from 3 females).

Five captive females from Hammond (Hessville), Ind., deposited a total of 366 eggs, the maximum per female being 89. These hatched in three to six days at room temperature.

[9]For details of larval anatomy, see "Structure of the Larva", page 28.

Dimensions of egg: .63 ± .05 mm. X .45 ± .07 mm. (57 eggs from 4 females; Hammond (Hessville), Ind.).

First-Stadium Larva.—Head dark blackish-brown. Prothoracic and suranal shields somewhat paler, greyish-brown. Trunk creamish-white to rich yellow. Setal bases black. Spiracles with black rims. Thoracic legs fawn-brown.

Head capsule width: 0.25 ± .01 mm. (30 larvae).

Duration of stadium: 3.9 ± 1.7 days (70 larvae).

Second-Stadium Larva.—Head medium to dark brown. Prothoracic and suranal shields paler, greyish-brown. Trunk cream to pale greenish-yellow; evanescent dorso-lateral yellowish-grey lines evident in some specimens. Spiracles with medium-brown rims. Thoracic legs fawn-brown.

Head capsule width: 0.37 ± .02 mm. (30 larvae).

Duration of stadium: 2.6 ± 1.3 days (70 larvae).

Third-Stadium Larva.—Head orange-fawn with some faint darker mottling on dorsal half. Prothoracic shield essentially concolorous with head capsule. Suranal shield paler than prothoracic shield, greyish-yellow.

Mid-dorsal band reddish-brown, varying somewhat in intensity of colouring, with an evanescent yellowish-grey mid-dorsal line. Subdorsal area consisting of pale-grey marginal lines, the dorsal of these being the wider and more prominent, and a median band of light green; the latter often suffused with reddish-brown, occasionally so heavily so that the green tone is suppressed. Supraspiracular area brownish-grey or greenish-grey, indistinctly marked with paler grey. Spiracles with light- to medium-brown rims. Spiracular band grey, often flushed with green, becoming poorly defined from the supraspiracular region as the larva grows. Ventral area concolorous with, or somewhat paler than spiracular band. Thoracic legs pale fawn-yellow.

Head capsule width: 0.56 ± .03 mm. (30 larvae).

Duration of stadium: 2.0 ± 1.0 days (70 larvae).

Fourth-Stadium Larva.—Head orange-fawn mottled dorsally and laterally with somewhat darker orange-brown. Prothoracic shield greenish-grey with three longitudinal whitish-grey lines. Suranal shield light greenish-brown with four whitish-grey longitudinal lines.

Mid-dorsal band reddish-brown with a discontinuous, often evanescent greyish-green median line. Subdorsal area olive-green medially, often with a slight brown or red suffusion; margined by whitish-grey lines and bisected by a whitish-grey median line. Supraspiracular area concolorous with median green or red of subdorsal region; with a discontinuous whitish-grey median line. Spiracles with medium-brown rims. Spiracular band concolorous with supraspiracular area, margined dorsally and ventrally by somewhat irregular whitish-grey lines. Ventral region greyish-green. Thoracic legs light orange-brown.

Head capsule width: 0.87 ± .04 mm. (30 larvae).

Duration of stadium: 2.6 ± 1.1 days (70 larvae).

Fifth-Stadium Larva (Figs. 183, 184).—Head clear fawn-yellow to orange-fawn. Slightly darker mottling on dorsal half of some specimens. Prothoracic shield fawn-yellow to yellowish-green. Suranal shield generally yellowish-green.

Mid-dorsal band reddish-brown, with a variably expressed, usually evanescent, dull greenish-grey median line. Subdorsal area dull greenish-grey to bright almost jade green; variably suffused with reddish-brown; margined on both sides with lines of whitish-grey; generally a whitish-grey median line also visible. Green of subdorsal area usually becoming brighter as the larva increases in size. Supraspiracular area essentially concolorous with subdorsal

area but usually with less reddish-brown suffusion; a commonly evanescent, broken and irregular, whitish-grey median longitudinal line through supraspiracular area. Spiracular band light green to greyish-green, margined dorsally and ventrally by whitish-grey lines. Spiracles with medium-brown rims. Suprapodal area usually slightly darker green than spiracular band; occasionally lightly mottled with whitish-grey. Mid-ventral area greenish-grey, generally paler than suprapodal area. Thoracic legs pale orange-yellow.

Head capsule width: 1.23 ± .06 mm. (30 larvae).

Duration of stadium: 3.5 ± 0.8 days (70 larvae).

Pupa (Fig. 118-121, 193).—Relatively stout, heavily sclerotized. Abdomen, and dorsum of metathorax dull mahogany-brown. Appendages, head, and dorsum of pro- and meso-thorax greenish-fawn. Metathoracic legs visible as elongate rectangles posterior to apex of proboscis. Seta L2 absent from surface of fourth abdominal segment. A row of pits on dorsum of fourth abdominal segment. Anterior halves of abdominal segments five to seven prominently pitted. Rims of spiracles high, forming short but prominent tubes. Cremaster consisting of four spines, the lateral pair having migrated to a position mostly ventral to median pair. Ventrolateral pair generally shorter and straighter than median pair.

Length to posterior margin of fourth abdominal segment: 6.2 ± 0.2 mm. (30 pupae).

SCHINIA AMARYLLIS (SMITH)

Fig. 163

1891. Smith, Trans. Am. Ent. Soc. 18: 130; *Heliophana.*
1893. Smith, Bull. U.S. Nat. Mus. 44: 290.
1903. Hampson, Cat. Lep. Phal. 4: 14.
1927. Draudt, Groszschmett. der Erde 7: 331.

Forewing dull medium brown marked with pale fawn-yellow or dirty white. Hind wing dark brown with white central area containing the large subquadrate discal spot.

Head and thorax clothed with greenish-grey hair. Abdomen brown-scaled, weakly overlaid with greenish-grey hair. Beneath, head, thorax, and abdomen pale dirty grey.

Transverse anterior line pale grey or pale fawn-yellow, margined on either side by lines of dark scaling; anterior and posterior thirds straight or weakly excurved, median third strongly excurved. Basal space with dark-brown or black scaling at immediate base of wing. A pale basal line from costa to a point posterior to median vein in most specimens. Transverse posterior line pale yellow or grey, margined both inwardly and outwardly by lines of dark scaling, deeply excurved opposite cell, then essentially straight to trailing margin. Median space pale fawn-yellow to dirty white, variably suffused with brown, often so heavily so as to suppress its paler tone. Orbicular circular, indistinct, immediately above median arc of t.a. line. Reniform dark-margined, more clearly defined than orbicular but often indistinct in dark specimens. A quadrate white, yellow, or pale orange spot between orbicular and reniform, most noticeable in dark specimens. Subterminal line pale yellow or grey, irregular, with an inwardly directed tooth opposite the cell and another near trailing margin of wing. Subterminal space usually somewhat paler than basal space, often severely constricted opposite cell. Terminal space concolorous with, or somewhat paler than subterminal space. A series of dark, intervenal, terminal lunules. Fringe concolorous with terminal space, commonly shot with darker scaling.

Basal region of hind wing brown; a narrow, brown, inner marginal band and a broad, brown, outer marginal band, the latter often containing a white streak toward inner angle. Central portion of wing white, containing a large subquadrate discal spot, the latter partially fusing with basal brown area.

Beneath, fore- and hind wings whitish-grey centrally. Some brown scaling at immediate base of forewing. A narrow basal dash extending to a point below reniform. Reniform and orbicular dark brown, situated as in obverse. A broad, brown, marginal band, bisected by a pale-grey submarginal line, the course of the latter following that of s.t. line. Inner edge of brown marginal band following course of t.p. line. Maculation of hind wing corresponding to that of obverse, but with basal brown area somewhat reduced.

Expanse: 21.3 ± 1.1 mm. (10 specimens).

Foretibia (Fig. 9) armed with two inner terminal claws as is that of *dobla;* commonly two additional slender inner, and three outer spines. Abdominal brushes present in male.

Male Genitalia (Fig. 28).—Valve long, flattened. About 25 setae in corona, mostly arranged in two rows at apex of valve. Ampulla short. Uncus slender at base, somewhat distended distally. Juxta with lateral points, and high, rounded dorsal margin. Vesica without basal diverticulum.

Female Genitalia (Figs. 43, 60).—Valve of ovipositor rounded apically, with a rather sparse clothing of minute setae, and with a few elongate, slender ones. Penultimate segment with a heavy clothing of fine spicules. A single, weak, moderately long signum on fundus bursae of specimens examined.

Distribution and Period of Flight.—The species is found in southern California. The only specimens examined with exact locality records were taken at Colton and La Jolla. The type was the only specimen examined with information on date of capture.

Type Material.—The type of the species, a male in excellent condition, is in the United States National Museum (Type No. 5108). The specimen was taken at Colton, California on March 20. It is dull grey-brown with dirty-white median space.

The food plant and immature stages of the species are unknown.

SCHINIA PERMINUTA (HY. EDWARDS)

Fig. 164

1881. Hy. Edwards, Papilio 1: 21; *Melicleptria.*
1883. Smith, Trans. Am. Ent. Soc. 10: 239; *Pseudotamila.*
1893. Smith, Bull. U.S. Nat. Mus. 44: 287.
1903. Hampson, Cat. Lep. Phal. 4: 28.
1927. Draudt, Groszschmett. der Erde 7: 332; *Melicleptria.*

dubitans Tepper (new synonymy)

1883. Smith, Trans. Am. Ent. Soc. 10: 245, 246; *Heliaca.*
1893. Smith, Bull. U.S. Nat. Mus. 44: 291.
1927. Draudt, Groszschmett. der Erde 7: 332; *Melicleptria.*

Forewing brown with cream median space. Hind wing dark brown with constricted white central band or two white spots.

Vestiture of head and thorax greenish-grey, usually with brown lines across apices of patagia. Abdomen dull dark brown with yellow terminus. Vestiture of underside of body dull brown.

Transverse anterior line yellow, broadly excurved throughout its length, varying considerably in outline, often somewhat undulating. Yellow of t.a. line often partially fusing with that of median space. A weak, pale-grey basal line between costal and median veins evident in most specimens. Basal area of wing

varying from medium dark brown to greenish-brown. Transverse posterior line yellow, fusing medially with yellow median space; broadly bisinuate; anterior half excurved, posterior half incurved. Median space with brown bands along costal and trailing margins of wing, yellow centrally. Reniform large, brown, fusing anteriorly with costal brown band. Subterminal line yellow, broad at costal margin, narrow for remainder of its length; with a sharp inwardly directed tooth opposite cell, then bisinuate to trailing margin; inwardly sharply defined, outwardly diffuse. Subterminal space generally broad, severely constricted opposite cell, concolorous with basal space. Terminal space narrow, paler brown than s.t. and basal spaces. A weak, dark terminal line evident in many specimens. Fringe concolorous with terminal space, shot with dark-brown dashes.

Hind wing chocolate-brown with two white central spots, the anterior roughly circular and the posterior quadrate. A variable amount of coalescence of the two spots in some specimens.

Beneath, forewing light chocolate-brown with white median band and apex. Reniform a large dark-brown patch in the median white band. Fringe largely brown but with admixture of cream scales. Hind wing light chocolate-brown with whitish apex and two white central spots corresponding to those of obverse. Fringe brown.

Expanse: 16.0 ± 0.9 mm. (12 specimens).

Foretibia (Fig. 10) commonly provided with single, long, stout, inner claw and two short outer spines. Male without abdominal brushes.

Male Genitalia (Fig. 32).—Valve short, moderately flat. Corona consisting of about eight slender setae. Ampulla relatively long. Uncus with a subapical dilation from which it tapers to pointed terminus. Juxta with an elongate dorsal point and short lateral points. Vesica without evident basal diverticulum.

Female Genitalia (Figs. 48, 65).—Valve triangulate; with relatively few setae arising individually from large circular membranous areas; thus valve with a rather coarse appearance. Penultimate segment entirely membranous, with a clothing of extremely short fine spicules. Four short signa on fundus bursae of specimens examined, the one immediately anterior to the appendix bursae usually the most prominent.

Distribution (Fig. 142) *and Period of Flight*.—The species is evidently confined to a portion of the Sierra Nevada – Cascade Axis, ranging from Plumas Co., Calif., in the south to the Klamath Mts. of Oregon in the north. Specimens examined were taken between June 17 and July 14.

Type Material.—Both of Henry Edward's specimens are in the collection of the American Museum of Natural History. Both specimens labelled "type" are females contrary to the original description which cites them as male and female. Neither specimen is in very good condition. One lacks the abdomen and the other has a bad split in the left hind wing. The specimen with abdomen present is here selected as lectotype. It expands 14 mm. The type is dull brown with a greenish cast. The white spots of the hind wing are small in comparison with most specimens and are discrete. Both specimens were taken on July 7 at Bear Valley, California in the Sierra Nevada. Tepper's type of *dubitans* is in the Michigan State College collection at East Lansing. It is a male in fair condition with appendages intact, but it is obviously badly faded. It was taken in "Nevada".

The life history of the species is unknown.

SCHINIA DOBLA (SMITH)

Fig. 165

1906. Smith, J. N.Y. Ent. Soc. 14: 19; *Melicleptria.*
1927. Draudt, Groszschmett. der Erde 7: 332.

Forewing greyish-brown with white median band. Hind wing uniform dark brown.

Head and thorax with white and black scaling overlaid by yellowish-grey hair. Abdomen grey anteriorly; remainder brown, except for a pale terminus. Beneath, body vestiture dirty grey.

Transverse anterior line of forewing consisting of three excurved arcs, the middle one being the largest and most strongly curved; t.a. white, its middle portion fusing with the white median space. Basal space brown suffused with grey scaling. A white basal line between costal margin and first anal vein in most specimens. Area of wing proximal to basal line usually olive-grey. Transverse posterior line white, for the most part discrete from median space, straight or somewhat excurved for the first two-fifths of its length, then bending sharply and deeply inward to a point below the reniform, then essentially straight to trailing margin. Thus, anterior half of median space broad, posterior half constricted. Median space white with brown costal band, largely suffused with brown in the posterior, constricted portion. Reniform large, brown; in centre of anterior, expanded portion of median space. Subterminal line white or marked only by colour change, irregular, forming three outward loops. Subterminal space concolorous with basal space. Terminal space paler than s.t. space, brown, but heavily suffused with grey and white scaling. A series of dark terminal lunules. Fringe concolorous with terminal space, with darker brown dashes opposite the veins.

Hind wing uniform dark brown except for small white patch in the middle of costal margin. Fringe white.

Beneath, forewing dark brown at base. Median area greyish-white, containing the dark-brown reniform. A submarginal brown area, slender anteriorly but enlarging gradually into a broad band posteriorly; its inner margin following course of t.p. line. Apex of wing greyish-white. Fringe brown. Apico-costal half of hind wing greyish-white, remainder dark brown. Fringe white.

Expanse: 19.8 ± .9 (6 specimens).

Foretibia (Fig. 8) with two inner terminal claws. In specimens examined, one or two additional slender inner, and three outer spines. Abdominal brushes present in male.

Male Genitalia (Fig. 29).—Valve long, moderately flat. Corona consisting of about 30 rather coarse setae arranged in two or three rows along the apical margin of the valve. Ampulla very short. Uncus long, moderately stout. Juxta with dorsal margin flattened, and with ventral margin broadly rounded. Vesica with a small, shallow diverticulum basally.

Female Genitalia (Fig. 51, 67).—Valve of ovipositor elongate, tapering to a sharply rounded apex. Valve with a moderate clothing of short, fine setae and a few elongate, slender ones. Penultimate segment clothed with rather short, coarse spicules. Fundus bursae commonly with four elongate, rather inconspicuous signa.

Distribution (Fig. 138) *and Period of Flight.*—The species has been taken on the deserts of southern California and at Tucson, Arizona on dates between March 20 and April 10.

Type Material.—The type is at the American Museum of Natural History. It is a female in generally fair condition, taken at Doble, California, on April 4. It expands 19 mm.

Life History and Habits

Although specimens of *Schinia dobla* are rare in collections, a number of females were taken, in the spring of 1952, ten miles east of Barstow on the Mojave Desert. These readily laid eggs, but unfortunately the larvae could not be reared near their native habitat, and the buds and blossoms of their food plant, *Franseria dumosa* Gray, were not available to feed them. They were offered a variety of other blossoms, including those of several composites but they fed indifferently on these and finally died.

In the spring of 1955, a second colony in which adults and subsequently larvae were abundant was located immediately east of the Fish Creek Mountains in Imperial County, California. Except for the egg, descriptions of the immature stages are based on material taken in this locality.

The eggs of the species are deposited beneath the sepals of male buds or between the florets of freshly opened male flowers. They are often greatly compressed and distorted in the tightly bound buds. The newly-hatched larva bores into the base of one of the sack-like florets to reach the large quantities of pollen with which each is filled. During the first stadium, the majority of pollen contained in any one floret is consumed and the larva remains within that floret until it has moulted for the first time. In the second stadium, the larva usually inserts only the anterior half of its body into a floret while feeding. During the third, fourth and fifth stadia, the larva feeds on the contents of buds and blossoms from a position on the stem or bud.

The larvae evidently feed exclusively on the staminate heads of the bur-sage. None of those observed, even last instars, fed or attempted to feed on the tough pistillate heads.

Immature Stages[10]

Egg (Fig. 82).—Smooth except for slight dimpling around micropyle. Pale greenish-yellow when deposited, approximating colour of inner surface of sepal. Little colour change during incubation until a few hours before hatching when head appendages become visible through chorion.

Primary cells mostly regularly arranged. Secondaries elongate, usually outwardly rounded; usually well-defined. Walls of cells beyond second series evanescent or not defined. Pores of moderate size, usually present at outer angles of cells of second, third and fourth series, and less commonly fifth series. Mean diameter of primary rosette, 0.056 ± 0.006 mm.; mean number of primary cells, 10.2 ± 1.5 (41 eggs from 3 females).

Eggs deposited by females taken near the Fish Creek Mountains, Imperial County, California, hatched in four to six days at room temperature, and the great majority hatched in five days.

Dimensions of egg: 0.63 ± 0.04 mm. x 0.42 ± 0.03 mm. (90 eggs from 3 females; Barstow, Calif.).

First-Stadium Larva.—Head dark brown or black. Prothoracic and suranal shields medium to dark smoky-brown. Trunk cream, becoming yellow or greenish-yellow after feeding. Spiracles with light- to medium-brown rims. Thoracic legs smoky-brown.

Head capsule width: 0.24 ± 0.01 mm. (38 larvae).

Duration of stadium: 2.9 ± 0.4 days (23 larvae).

[10]For details of larval anatomy, see "Structure of the Larva", page 28.

Second-Stadium Larva.—Head dark brown or black. Prothoracic and suranal shields somewhat lighter, smoky-brown. Trunk greyish-cream, light yellow or greenish-yellow. Spiracles with medium- to dark-brown rims. Thoracic legs dark smoky-brown.

Head capsule width: 0.38 ± 0.02 mm. (26 larvae).

Duration of stadium: 2 ± 0 days (23 larvae).

Third-Stadium Larva.—Head orange-brown mottled dorsally with somewhat darker brown. Prothoracic shield pale greenish-fawn; with pale-yellow median, and paired submarginal, or occasionally marginal, lines. Suranal shield light fawn, variably suffused with yellow; often with a pair of pale-yellow longitudinal lines.

Mid-dorsal band greenish- or yellowish-grey, often discontinued intersegmentally. Subdorsal area yellow, with segmental patches of greenish- or yellowish-grey, the latter often fusing mesally with mid-dorsal band. Supraspiracular area similar in colour to, but paler than mid-dorsal band. Spiracular band yellow, poorly defined from supraspiracular and suprapodal areas. Spiracles with medium- to dark-brown rims. Ventral region light smoky-green. Thoracic legs smoky-brown.

Head capsule width: 0.61 ± 0.03 mm. (26 larvae).

Duration of stadium: 2 ± 0 days (23 larvae).

Fourth-Stadium Larva.—Head greyish-cream to pale orange-brown, mottled and suffused with greyish-brown or chocolate-brown; frons generally free of suffusion and mottling. Prothoracic shield pale green variably suffused with brown, usually lightly so; with white median, and light-yellow or white submarginal lines. Suranal shield yellow or green, in some instances lightly suffused with light greyish-brown; often a pair of longitudinal yellow lines evident.

Maculation of trunk most distinctive. Mid-dorsal band and subdorsal areas fusing into a continuous yellow dorsal region; in this yellow area on each segment, an oval, green or brown, median spot and paired lateral green or brown circular spots; the three spots on each segment often partially coalescing; lateral spots sometimes fusing ventrolaterally with supraspiracular area. Supraspiracular area narrow, green or occasionally brown. Spiracular band yellow with segmental patches of green or brown that fuse dorsally with supraspiracular area. Spiracles with dark-brown or black rims. Ventral region light greyish-green or light greyish-brown. Thoracic legs cream suffused with green to smoky-fawn.

Head capsule width: 1.12 ± 0.05 mm. (23 larvae).

Duration of stadium: 2.1 ± 0.4 days (23 larvae).

Fifth-Stadium Larva (Figs. 185, 186).—Head light orange-brown, dorsally suffused and mottled with medium to light chocolate-brown. Prothoracic shield fawn to dark brown, with white median and pale-yellow or white submarginal lines. Suranal shield yellow marked with pale fawn-grey.

Mid-dorsal band and subdorsal areas forming a continuous yellow, or greenish-yellow dorsal region; each segment of dorsal region with reddish-brown, purplish-brown, green or black, trilobed bat-like patch; dark patch on each segment commonly with pale-yellow, median spot or spots. Supraspiracular area brown, green, or black, with an irregular and discontinuous, light-yellow median line. Spiracular band broad, yellow; with brown, green or black patch on each segment. Dorsal patch, supraspiracular band and spiracular patch sometimes partially fused in middle of each segment. Spiracle

in a circle of yellow toward lower margin of dark spiracular patch; spiracles with black rims. Suprapodal area yellow, greyish-yellow, green or greyish-green. Mid-ventral area paler than suprapodal area. Thoracic legs pale yellow suffused with light to medium smoky-brown.

Head capsule width: 1.75 ± 0.13 mm. (27 larvae).

Duration of stadium: 6.3 ±1.2 days (23 larvae).

Pupa (Figs. 128-130, 194).—Relatively stout, heavily sclerotized. Medium orange-brown, often suffused on head, thorax and appendages with olive or green. Mesothoracic legs longer, relative to length of proboscis, than those of *triolata*, but shorter than those of *villosa*. Visible distal portions of metathoracic legs usually reduced to triangular plates flanking apex of proboscis. Seta L2 of fourth abdominal segment evident as darkly pigmented spot near outer margin of wing. Fourth abdominal segment without punctations. Abdominal segments five to seven heavily pitted. Rims of spiracles low. Cremaster consisting of four, slender, straight or weakly curved spines, the median pair being somewhat longer.

Length to posterior margin of fourth abdominal segment: 7.6 ± 0.3 mm. (20 pupae).

SCHINIA ANTONIO (SMITH)

Fig. 166

1906. Smith, J. N.Y. Ent. Soc. 14: 16; *Melicleptria.*
1927. Draudt, Groszschmett. der Erde 7: 331.

Forewing green to olive-brown, flushed with pink. Hind wing uniform dark brown.

Vestiture of head and thorax olive-brown, that of abdomen darker brown; all three flushed with pink. Terminus of abdomen fawn-yellow. Beneath, head, prothorax, and legs light brown. Remainder of underside of body chocolate-brown.

In some specimens transverse anterior present as a greyish-white line; in other specimens indicated only by colour change. T.a. angling outward from costa to subcostal vein, then essentially straight to trailing margin. Basal area green to olive-brown with paler scaling at extreme base of wing. In most specimens basal space flushed with pink, especially strongly so immediately proximal to t.a. line. Transverse posterior line straight, marked only by colour change. Median space pale yellow with varying amounts of brown suffusion. Pink bands extending along costal and trailing margins from basal to subterminal spaces in many specimens. Reniform small, narrow, dark olive to dark brown. In many specimens a diffuse median line traversing median space and passing through reniform. Subterminal line somewhat irregular, but course essentially straight, marked only by colour change. Subterminal space narrow, concolorous with basal space. Terminal space pale fawn to pale yellow. A dark terminal line. Fringe pale greyish-yellow.

Hind wing uniform dark brown. Fringe for most part greyish-white, brown at outer angle of wing.

Beneath, forewing brown centrally. A brown band along costal margin from base almost to apex. Apical area of wing dull fawn-yellow, in some specimens flushed with pink. A band of dull fawn-yellow along trailing margin. A patch of fawn proximal to the dark-brown reniform in central brown portion of wing. Hind wing mostly brown, flushed with pink; dull fawn-yellow along costal margin and at apex.

Expanse: 14.7 ± 0.7 mm. (7 specimens).

Foretibia (Fig. 13) armed with strongly curved inner terminal claw; commonly two additional inner spines and three or four stout, fairly prominent outer spines. Male without abdominal brushes.

Male Genitalia (Fig. 30).—Valve narrow and elongate. Corona consisting of about ten fine setae more or less clumped at apex of valve. Ampulla represented only by a minute hairy protuberance. Uncus moderately short and stout. Juxta broader ventrally than dorsally. Dorsal margin straight. Vesica without evident basal diverticulum.

Female Genitalia (Figs. 52, 68).—Valve of ovipositor relatively short and broad, rounded terminally. A dense clothing of minute setae on valve; a very few longer setae. Penultimate segment clothed with minute spicules. Fundus bursae with two prominent, rounded signa in specimens examined.

Distribution and Period of Flight.—The species is evidently confined to south-central Texas. Moths examined were taken at San Antonio, Pharr, and Brownsville, in late March and in the first half of April.

Type Material.—The type is a male in the collection of the United States National Museum. It was taken at San Antonio, Texas in the second week of April. The specimen unfortunately lacks the left forewing. The pigmentation of the type specimen is rather intense in comparison with other members of the series examined. It expands 14 mm.

The life history of the species is unknown.

SCHINIA HONESTA (GROTE)

Fig. 167

1881. Grote, Papilio 1: 77; *Melicleptria.*
1883. Smith, Trans. Am. Ent. Soc. 10: 245.
1893. Smith, Bull. U.S. Nat. Mus. 44: 289.
1903. Hampson, Cat. Lep. Phal. 4: 22; *Heliothis.*
1912. Barnes & McDunnough, Contrib. Nat. Hist. Lep. N.A. 1(4): 39.
1927. Draudt, Groszschmett. der Erde 7: 332; *Melicleptria.*

kasloa (Smith)

1903. Smith, Trans. Am. Ent. Soc. 29: 208; *Melicleptria.*
1904. Dyar, Proc. U.S. Nat. Mus. 27: 874; sunk to *honesta.*

Forewing olive-brown marked with yellow. Hind wing dark brown or black, with white central area.

Head and thorax clothed with pale greyish-green hair. Abdomen dark-scaled, variably overlaid with grey-green hair. Beneath, body creamy-white or grey. Transverse anterior line most irregular, evident as a grey shade or marked only by colour change; essentially straight from costal margin to first radial, then with a sharp, deep, basally directed tooth between radial and median veins; excurved below median vein, then slanting basally to trailing margin. Basal space olive-green. A weak, pale-grey basal line in many specimens. Transverse posterior line shallowly excurved opposite cell, then essentially straight to trailing margin; yellow, fusing with yellow of median space in most specimens, and thus marked for most part only by colour change. Median space pale yellow or white, with bands of olive-brown scaling along costal and inner margins of wing. Spots olive-brown. Orbicular circular, immediately above outward arc of t.a. line. Reniform broad. A short broadly rounded claviform distal to t.a. line in most specimens. Subterminal line broad, irregular, yellow, inwardly sharply defined, outwardly diffuse, cutting into s.t. space opposite cell and toward trailing margin, giving the latter an outwardy trilobed appearance. In a few cases, s.t. line very broad reducing terminal space to a narrow marginal band. Subterminal space concolorous with basal

space. Terminal space somewhat paler. In most specimens a dark-brown outer marginal line. Fringe concolorous with terminal space or somewhat paler.

Hind wing dark brown at base. A broad, brown, outer marginal band and a narrow, brown, inner marginal band. Commonly four intervenal pale-yellow or white spots in middle of outer marginal band. Costal and central areas of wing pale yellow or white. A large discal spot in central white area, fused or partially fused with basal brown of wing. Fringe brown inwardly, white outwardly.

Reverse of fore- and hind wings pale yellow or white, marked with brown. Forewing with a broad basal dash. Area between basal dash and trailing margin of wing commonly brown-scaled. Orbicular and reniform brown. A brown subterminal band, narrow anteriorly, broad posteriorly. Fringe yellow or white inwardly, brown outwardly, or uncommonly entirely brown. Hind wing with discal spot somewhat reduced from that in obverse. A brown inner marginal band and a partial outer marginal band posteriorly, the latter continuing to costal margin of wing as a weak submarginal line. Discal spot of hind wing discrete, somewhat reduced from that of obverse. Fringe pale yellow.

Expanse: 24.2 $\pm$ 1.8 mm. (29 specimens).

Foretibia (Fig. 14) commonly armed with three or four inner spines and three or four outer spines. Abdominal brushes present in male.

Male Genitalia (Fig. 31).—Valve long, moderately broad and flat. Corona consisting of about 10 setae, mostly clumped at apex of valve. Ampulla slender, elongate. Uncus slender, slightly tapered from base to apex. Juxta rather shallow dorso-ventrally, with prominent lateral points, and with dorsal margin broadly pointed.

Female Genitalia (Figs. 47, 64).—Valve of ovipositor triangulate, apically pointed. A moderate covering of short setae and a few elongate slender ones. Intersegmental membrane anterior to valve often with considerable secondary sclerotization. Penultimate segment densely clothed with short, rather coarse spicules. Fundus bursae generally with four, moderately elongate signa.

Distribution (Fig. 141) *and Period of Flight*.—The species ranges from southern British Columbia in the north, south along the Sierra Nevada-Cascade axis to Mineral King in Tulare Co., Calif., and south along the Rocky Mountain System to Strontia Springs, Colorado. The species has been poorly collected in the Rocky Mountains. Specimens examined were taken between the first of June and first of August.

Type Material.—The type of *honesta* taken at Mt. Hood, Oregon, is a male in the collection of the United States National Museum (Type No. 33704). It is in generally good condition but is thoracically "scalped". It expands 23 mm. Smith's type of *kasloa* taken at Kaslo, B.C., on June 7 is at the American Museum of Natural History. Expanding 25 mm., it is a female in beautiful condition. The two "cotypes" of *kasloa* are in the United States National Museum.

The life history of the species is unknown.

Immature Stages

Egg (Fig. 81).—Primary cells regularly arranged in most cases. Secondary cells well defined. Tertiary and quartenary cells usually evanescent. Differing from other species of the group in presence of several series of randomly distributed pentagonal or hexagonal cells beyond quartenary cells. Pores of moderate size, commonly present at outer angles of third, fourth, and fifth

series of cells. Mean diameter of primary rosette, .087 ± .007 mm.; mean number of primary cells, 17.0 ± 1.9 (44 eggs from 4 females).

Dimensions of egg: .89 ± .07 mm. x .68 ± .06 mm. (73 eggs from 4 females; Nickel Plate, Hedley, B.C., 5,500 ft.; Kaslo, B.C.; Blackwall, Manning Park, B.C., 6,000 ft.; Mammoth Lake, Mono Co., Calif.).

SCHINIA SCARLETINA (SMITH)

Figs. 168, 169

1900. Smith, Proc. U.S. Nat. Mus. 22: 487; *Palada.*
1903. Holland, Moth Book, p. 229.
1927. Draudt, Groszschmett. der Erde 7: 328.
1955. Comstock, Bull. So. Calif. Acad. Sciences 54 (2): 62; life history discussed.
1955. Sala, Bull. So. Calif. Acad. Sciences 54(3): 151; life history discussed.

Forewing golden-brown to chocolate-brown, variably suffused with red. Hind wing uniform dark brown or black.

Vestiture of head and thorax mostly fawn or fawn-grey; some darker-brown scaling present. Abdomen dark-brown scaled above with fawn terminal tuft. Beneath, body fawn or fawn-grey.

Transverse anterior line of forewing white or yellow, excurved or forming a broad, outwardly directed V. Basal space golden-brown to chocolate-brown. Anterior two-thirds of transverse posterior line excurved; remainder straight or shallowly incurved. Median space fawn or yellow, heavily suffused with brown. Median space occasionally bisected by the fusion of t.a. and t.p. lines or by the fusion of basal and subterminal spaces. Reniform usually obscured or obliterated by dark scaling in median space; in some cases evident as an elongate dark shade. Subterminal line sinuate, very irregular. Subterminal space concolorous with basal space. Terminal space pale fawn or yellow, with lines of dark scaling along the veins. Fringe darker than terminal space, consisting of fawn and brown scales.

Hind wing uniform dark brown, or black, with concolorous fringe.

Beneath, forewing mostly red, varying from orange-red to bright strawberry-red. A small area of dark brown at base of wing. An outer terminal or subterminal brown band variably expressed; totally absent in some cases. Apex yellow or fawn. Fringe golden-brown. Hind wing uniform dark brown or black except for a narrow costal band of yellow or fawn, which is often flushed with red or pink. Fringe dark brown or black.

Expanse: 19.3 ± 1.3 mm. (52 specimens).

Foretibia (Fig. 15) armed with a long terminal inner claw and two short outer spines. No variation in the number of foretibial spines in specimens examined. Abdominal brushes absent in male.

Male Genitalia (Fig. 35).—Valve flattened, broader apically than basally. Corona consisting of half dozen or so fine setae clumped at extreme apex of valve. Ampulla absent. Uncus long, slender. Juxta small, dorso-ventrally shallow, varying considerably in shape. Vesica without basal diverticulum.

Female Genitalia (Figs. 53, 70).—Valve triangulate, sharply rounded apically. Surface of valve moderately clothed with short setae. A few, more elongate setae interspersed among these. A number of very long slender setae toward anterior margin of valve. Penultimate segment densely set with small scale-like structures. Two or three elongate, minute points arising from the distal margins of each of these. Fundus bursae without signa in specimens examined.

Distribution (Fig. 145) *and Period of Flight.*—The species ranges from southern California eastward to Arizona and New Mexico and northward to Utah and Colorado. Specimens from coastal California tend to be darker and

with a less decided reddish tone on the upper surface than those from the interior of southern California and other localities. Specimens examined were collected between the first of June and the middle of September.

Type Material.—The species was described on the basis of three specimens. Of these there is a male "cotype" from California at the American Museum of Natural History, and two specimens, labelled "male type" and "female type" at the United States National Museum (Type No. 4816). Both of the specimens at the United States National Museum are females, however. The supposed male, collected in San Diego Co., California expands 16.5 mm. and has the typical chocolate-brown colouring of coastal specimens. The right forewing of this specimen is unfortunately missing. The other specimen, labelled merely "Utah", expands 19.5 mm. and is reddish-brown. Its right hind wing has been split in spreading, but it is otherwise in good condition. The Utah specimen is here selected as lectotype.

In describing *Palada* as a new genus to include *scarletina*, Smith overlooked the spines on mid and hind tibiae which are often difficult to see among the scales and hair of the leg.

Life History and Habits

Two articles dealing with the life history of *Schinia scarletina* have appeared in the recent literature, one by Comstock (1955) and a second by Sala (1955). The present study was made possible by discovering, in the spring of 1955, two colonies on the Colorado Desert of southern California, one at Fan Hill Wash east of Thousand Palms, Riverside County, and the other along the highway east of Desert Center, Riverside County. Material on which subsequent rearing data are based, was obtained in the latter locality. In the areas in which the moths were taken, the larva feeds on *Stephanomeria pauciflora* (Torr.) A Nels. Comstock (1955) states that on the coast of southern California, *scarletina* feeds on *Stephanomeria virgata* Benth.

Scarletina has the most distinctive flight of any of the diurnal species that have been observed. As the moth hovers over the heads of the food plant, preparatory to alighting, it somewhat resembles a bumble-bee.

During the process of egg-laying, the ovipositor is inserted into the top of the blossom and the egg is deposited among the bases of the florets. During the early stadia, the larva feeds almost exclusively on the florets but during the third or fourth stadia it begins to consume the seeds as well. The larva generally remains concealed within the head until it has moulted into the fourth stadium. During the fourth and fifth stadia the larva feeds on the heads from a position on the stem. The head is attacked from the side and generally both florets and seeds are consumed, leaving only a partial shell of sepals.

Of the 44 larvae that were individually reared to pupation, one larva required six stadia to complete its development. The remaining larvae required only the normal five stadia.

The disposition of a number of adults to emerge from captive pupae only a few days after pupation suggests that when sufficient moisture is present to prolong the blossoming period of the food plant, at least a partial second generation may complete its development in the desert.

Immature Stages[11]

Egg (Fig. 85).—Smooth. Two colour phases: pale yellow and pearl-white, both developing equally well. No colour change until a few hours before hatching, when ocelli become visible through chorion.

[11]For details of larval anatomy, see "Structure of the Larva", page 28.

Cells often irregularly arranged so that series of cells difficult to distinguish. Primary cells usually regularly arranged. Secondary and majority of tertiary cells elongate and outwardly rounded. Cells of fourth and subsequent series commonly broader and straight-sided. Cells well defined to fourth or fifth series, visible to fifth to seventh series. Pores small, inconspicuous, few. Two or three series of pores commencing at third to fifth series. Mean diameter of primary rosette, 0.057 ± 0.006 mm.; mean number of primary cells, 14.2 ± 1.8 (29 eggs from 5 females).

The greatest number of eggs deposited by any individually confined female of *scarletina* was 15. Five captive females in a single oviposition jar, however, deposited a total of 99 eggs. These hatched in three to five days at room temperature, with the majority hatching in four days.

Dimensions of egg: 0.63 ±0.05 mm. x 0.43 ± 0.03 mm. (61 eggs from 6 females; Desert Center, Riverside Co., Calif.).

First-Stadium Larva.—Head medium to dark smoky-brown. Prothoracic shield concolorous with, or somewhat darker than head; commonly with pale-yellow or pale-grey median line. Suranal shield pale grey spotted with dark brown. Trunk showing same two colour phases as egg, light yellow or white; becoming segmentally mottled with light golden-brown as larva increases in size.

Head capsule width: 0.25 ± 0.02 mm. (25 larvae).

Duration of stadium: 5.3 ± 0.9 days (43 larvae).

Second-Stadium Larva.—Head cream to dark cloudy-fawn, variably mottled with medium to dark smoky-brown, often heavily so. Prothoracic shield dark smoky-brown or blackish-brown, usually with pale-grey median line and pale-grey lunate area on either side at anterior margin. Suranal shield dark smoky-brown or blackish-brown.

Trunk cream, segmentally marked with golden-brown or light chocolate-brown; brown becoming more prominent and extensive as larva grows. Often a lateral and a dorsolateral pale grey or cream lines on each side of trunk. Spiracles with dark-brown or black rims. Thoracic legs dull black.

Head capsule width: 0.38 ± 0.02 mm. (25 larvae).

Duration of stadium: 4.6 ± 1.1 days (43 larvae).

Third-Stadium Larva.—Head cream, fawn, or cream and fawn, variably mottled with medium to dark chocolate-brown. Arcs, free of mottling, diverging upward and outward from centre of face. Prothoracic shield dark brown or black with grey, transverse, anterior, marginal band; a cream, median longitudinal line and often incomplete submarginal, longitudinal bands. Suranal shield medium to dark smoky-brown, occasionally with a cream spot on either side.

Mid-dorsal band golden-brown, rust-brown, or light purplish-brown. Subdorsal area with cream or yellow marginal lines and a median band concolorous with, or somewhat paler than mid-dorsal band. Supraspiracular area generally darker brown than mid-dorsal band, lightly mottled with cream or yellow. Spiracular band cream or yellow. Spiracles with dark-brown or black rims. Suprapodal area brown, similar in colour to, but paler than supraspiracular area; marked with cream. Mid-ventral area grey, pinkish-grey or greenish-grey. Thoracic legs black.

Head capsule width: 0.58 ± 0.04 mm. (25 larvae).

Duration of stadium: 4.0 ± 0.9 days (43 larvae).

Fourth-Stadium Larva.—Head cream, creamy-grey, or fawn; often suffused with light orange; variably mottled with medium chocolate-brown. Prothoracic

shield dark brown or black; with grey, transverse, anterior marginal band; a broad, yellow or cream, median longitudinal line, and narrower, yellow or cream, submarginal longitudinal lines. Suranal shield smoky-fawn to dark, smoky-brown; with or without marginal or submarginal, yellow or cream bands.

Mid-dorsal band dull, purplish-brown. Subdorsal area with yellow, or occasionally cream, marginal lines, and a purplish-brown or reddish-brown, median band. Supraspiracular area darker purplish-brown than mid-dorsal band; one or two small, bright yellow or cream spots on each segment forming a broken median longitudinal line. Spiracular band white, cream or light yellow; often with a suggestion of a grey or mauve, median longitudinal line. Spiracles with dark-brown or black rims. Suprapodal area grey or greenish-grey, variably suffused with mauve. Mid-ventral area grey or greenish-grey. Thoracic legs black, or occasionally dark smoky-brown.

Head capsule width: 1.04 ± 0.06 mm. (25 larvae).

Duration of stadium: 4.6 ± 1.1 days (43 larvae).

Fifth-Stadium Larva (Figs. 187, 188).—Head fawn with creamy-white ventrolateral areas; variably mottled with light to medium brown. Prothoracic shield mauve, or fawn toned with mauve; with cream median band and cream submarginal lines; often a black patch on either side. Suranal shield poorly or not distinguished from remainder of trunk.

Trunk reddish-mauve, or greyish-straw suffused with mauve. Mid-dorsal band reddish-mauve; darker laterally than mesally. Subdorsal area concolorous with or somewhat paler than mid-dorsal band; margined on either side by an irregular and broken creamy-white line. Supraspiracular area usually somewhat darker than mid-dorsal and subdorsal areas; usually with one or two creamy-white spots on each segment. Spiracular band creamy-white. Spiracles with black rims. Suprapodal area whitish-grey toned with mauve. Mid-ventral area whitish-grey. Thoracic legs straw-coloured, marked at apex of each segment with dark brown.

Head capsule width: 1.77 ± 0.12 mm. (15 larvae).

Duration of stadium: 4.3 ± 1.1 days (43 larvae).

Pupa (Figs. 131-133).—Slender, lightly sclerotized. Head, thorax and appendages ochre, or greenish-ochre; abdomen light orange-brown. Mesothoracic legs very short relative to length of proboscis. Visible distal portions of metathoracic legs represented by triangular plates flanking apex of proboscis. Seta L2 absent from surface of fourth abdominal segment. Fourth abdominal segment not punctate. Pitting on abdominal segments five to seven approximating that of *triolata*. Spiracular rims relatively low. Cremaster consisting of four slender, straight or weakly curved, diverging spines, the median pair being somewhat longer and stouter.

Length to posterior margin of fourth abdominal segment: 7.0 ± 0.3 mm. (20 pupae).

SCHINIA PERSIMILIS (GROTE)

Figs. 170, 171

1873. Grote, Bull. Buff. Soc. Nat. Sci. 1: 117; *Heliothis*.
1883. Smith, Trans. Am. Ent. Soc. 10: 244; sunk to *villosa*.
1883. Grote, Trans. Am. Ent. Soc. 10: 266; considered a distinct species.
1893. Smith, Bull. U.S. Nat. Mus. 44: 288; considered variety of *villosa*.
1903. Hampson, Cat. Lep. Phal. 4: 20; Heliothis; sunk to *villosa*.
1912. Barnes & McDunnough, Contrib. Nat. Hist. Lep. N.A. 1(4): 39; considered distinct species.
1927. Draudt, Groszschmett. der Erde 7: 332; *Melicleptria*.

flavidenta (Smith)
1906. Smith, J. N.Y. Ent. Soc. 14: 20; *Melicleptria.*
1917. Barnes & McDunnough, Check List, p. 37; sunk to *persimilis.*
aberration *coloradica* (Strand)
1915. Strand, Archiv. für Natür. A 12: 143; *Heliothis;* described as an aberration of *villosa.*
1938. McDunnough, Check List, part 1, p. 103; *Melicleptria;* sunk to *persimilis.*

Forewing green or greenish-brown, with yellow median area; usually suffused with red in basal and subterminal spaces. Hind wing dark brown or black with white central area, or three white central spots.

Head and thorax clothed with olive-green hair. Abdomen with brown scaling and an overlay of olive hair. Under surface of body clothed with pale dirty-grey hair.

Transverse anterior line of forewing straight from costal margin to a point posterior to subcostal vein, turning abruptly outward for some distance, then curving posteriorly and angling inward to trailing margin; marked only by colour change. Basal space green, heavily suffused with red in most specimens except at immediate base of wing. Transverse posterior line marked only by colour change, excurved opposite cell, then essentially straight or with a slight basal slant from a point below reniform to trailing margin. Median space yellow with green or red costal and inner marginal bands. Usually a grey shade in posterior portion of median space. Orbicular spot above arc of t.a. line, circular in most cases, green, greenish-grey or red. Orbicular usually fusing posteriorly with claviform, located immediately distal to arc of t.a. line. Reniform somewhat elongate, often fusing anteriorly with median costal band as does orbicular. Subterminal line irregular, turning outward posteriorly to outer angle but for most part parallel to outer margin of wing. Subterminal space concolorous with basal space. Terminal space olive-green, usually without any reddish tone. A generally pale-brown, rather diffuse terminal line. Fringe concolorous with, or somewhat darker than, terminal space.

Hind wing black or brown with white central area containing large discal spot. In many specimens brown or black more extensive, and central white area trisected by partial fusion of discal spot and marginal bands. Often an indistinct white streak in middle of outer marginal band. Fringe white.

Reverse of both wings white or grey marked with dark brown. A brown costal marginal band on forewing from base to a point beyond orbicular. A brown basal dash. Area between basal dash and trailing margin often brown-scaled. Median space white suffused with grey, containing the reniform and orbicular spots. Orbicular fusing anteriorly with costal band and posteriorly with basal dash, thus isolating a sagittate white spot proximally. A brown patch at outer angle of wing, attenuated anteriorly to costal margin as a gradually diminishing submarginal band. Apical area of wing white. Fringe grey or brown, or brown basally and grey distally. Hind wing brown at base; with a brown band extending along inner margin to outer angle, then anteriorly along outer margin for about half its length. A brown submarginal line from terminus of outer marginal band to costal margin of wing. Apical and central area of wing white or greyish-white, containing the large discal spot which may be partially fused with the brown base of wing.

Expanse: 21.9 $\pm$ 0.9 mm. (47 specimens).

Foretibia (Fig. 16) commonly provided with two or three inner and two or three outer spines in addition to inner terminal claw. Abdominal brushes present in male.

Male Genitalia (Fig. 33).—Valve long, stout, moderately broad basally, narrow distally. Corona consisting of about 21 long, moderately stout setae,

arranged mostly in one or two irregular rows along apical margin of clasper. Ampulla fairly long, incurved, pointed. Uncus slender, tapering from base to pointed apex. Juxta shallow dorso-ventrally, broadly rounded ventrally, with lateral and dorsal points. Vesica with an elongate basal diverticulum.

Female Genitalia (Figs. 49, 69).—Valve variable in shape and size; broadly rounded distally; densely clothed with short fine setae and with a number of slender, elongate ones. Penultimate segment densely clothed with extremely short, fine spicules. In some instances bursa embellished with four elongate, slender signa; in most cases, however, only two, shorter signa present.

Distribution (Fig. 137) *and Period of Flight.*—The species ranges from western Colorado and Utah north to the Cypress Hills of southwestern Saskatchewan and the Red Deer River of Alberta. I have examined a single specimen taken in the Steens Mts. of south-eastern Oregon. The Utah specimens examined were from the Barnes collection and were without exact date or locality records. Other specimens examined, were taken between the latter part of June and the first week or two of August.

Type Material.—Grote's type, described from "Colorado Territory", is in the Tepper collection at the Michigan State College in East Lansing. It is a female in good condition except for being thoracically "scalped". It expands 22 mm. Smith's type, taken in Utah in July, is at the American Museum of Natural History. Expanding 21 mm., it is a male in beautiful condition. Both types are suffused with red as apparently are most individuals.

The life history of the species is unknown.

Immature Stages

Egg (Fig. 75).—Primary cells mostly regular. Secondary and tertiary cells well defined. Quartenary cells evanescent. Cells beyond fourth series usually defined only by pores, but in some cases, all walls of fifth and sixth series partially defined. Pores relatively small but usually readily visible. A few pores commonly present at outer angles of secondary cells; more abundant and prominent, however, at outer angles of cells from third to eighth or ninth series. Mean diameter of primary rosette, .062 ± .005 mm.; mean number of primary cells, 12.5 ± 1.7 (13 eggs from 1 female).

Dimensions of egg: .57 ± .03 mm. x .44 ± .03 mm. (15 eggs from 1 female; Chimney Gulch, Golden, Colo.).

SCHINIA PULCHRIPENNIS (GROTE)

Fig 172

1874. Grote, Proc. Bost. Soc. Nat. Hist. 16: 241; *Heliothis.*
1875. Grote, Bull. Buff. Soc. Nat. Sci. 2: 220; *Adonisea.*
1882. Grote, Ill. Ess. Noct. N.A., p. 62.
1883. Smith, Trans. Am. Ent. Soc. 10: 244; *Melicleptria.*
1893. Smith, Bull. U.S. Nat. Mus. 44: 288.
1900. Strecker, Lep. Rhop. & Het., supplement 3, p. 34.
1903. Hampson, Cat. Lep. Phal. 4: 19; *Heliothis.*
1903. Holland, Moth Book, p. 230; *Melicleptria.*
1927. Draudt, Groszschmett. der Erde 7: 331.
1942. McElvare, Bull. Brook. Ent. Soc. 37: 169.

variety *languida* Hy. Edw.
1881. Hy. Edwards, Papilio 1: 20; *Adonisea;* described as a variety of *pulchripennis.*

Forewing purplish-red with blue lines and with pale yellow or yellowish-green areas. Hind wing dark brown with white or cream central area.

Head with purple, grey and black hair on vertex. Front with black and ochre scaling. Thorax clothed with purple, grey, and black hair above, and

greyish-yellow hair beneath. Legs with grey and purple hair. Abdomen black, clothed with greyish-yellow hair.

Transverse anterior line of forewing blue, excurved throughout its length, most strongly so between subcostal and median veins. Basal space uniform purplish-red, with some grey vestiture at immediate base of wing. Transverse posterior line usually blue, in a few specimens marked only by colour change; essentially straight or weakly sinuate. Median space yellow or yellowish-green with purplish-red costal band and a purplish-red area posteriorly. Median space often heavily suffused with purplish-red, in some specimens so heavily so as to suppress the yellow and green. Reniform dark purplish-red, narrow, elongate, fusing anteriorly with median costal band. Reniform evident in specimens heavily suffused with purplish-red only as a darker spot in median space. Usually a pale dash proximal to reniform. Subterminal line somewhat irregular but course mostly straight. Subterminal space a narrow, dark, purplish-red band distal to t.p. line. Terminal space wide, paler than subterminal space, often with an ochre tone. Fringe consisting of reddish-purple and black scales. Reddish-purple of forewing entirely replaced by greyish-green in a few specimens examined.

Hind wing black or dark-brown with quadrate white central spot. In some specimens a dark discal spot partially visible but usually latter entirely incorporated into black or dark brown at base of wing. Fringe white.

Beneath, ochre, marked with brown and purplish-pink. Forewing with pink along costa and at apex. Base of forewing brown. A narrow brown reniform and a brown outer submarginal band. Hind wing brown at base, pink along costa and at apex; remainder of wing ochre. Fringes of both fore- and hind wing ochre, variably suffused with purplish-pink.

Expanse: 19.7 $\pm$ 1.4 mm. (183 specimens).

In addition to inner terminal claw, foretibia (Fig. 17) usually armed with one or two inner and two outer spines. Abdominal brushes present in male.

Male Genitalia (Fig. 37).—Valve stout, narrower distally than basally. Corona consisting of about fifteen setae, mostly arranged in a single row. Ampulla moderately long, slender. Uncus elongate, somewhat swollen mesally in many specimens. Juxta large, roughly diamond-shaped. Vesica with a well-developed basal diverticulum.

Female Genitalia (Figs. 50, 66).—Valve pointed, with a moderate covering of short, fine setae and a few elongate ones. Penultimate segment well clothed with fine spicules. Fundus bursae of some specimens with four elongate slender signa, but in most specimens signa shortened and reduced in number.

Distribution (Fig. 139) *and Period of Flight.*—The species ranges northward from San Diego and the Mojave Desert through the Coast Ranges and the Central Valley of California to Sonoma Co., California. Specimens examined were taken during March and April. The species also occurs in the desert of southern Arizona, specimens having been examined from Palmerlee and Redington. Occasional specimens from some of the older collections, labelled Colorado, Washington or Montana have been encountered. These records should probably be discounted until further, more reliable data are available.

Type Material.—The species was described by Grote on the basis of a single male. The type is not in the Grote Collection at the British Museum (Natural History). There is a specimen from the type lot at the Museum of Comparative Zoology and a male and a female from the type lot at the American Museum of Natural History. Probably none of these is the type. The latter may be

lost. The male at the American Museum fits Grote's description well. It expands 22 mm. The type of *languida* (Hy. Edw.) is a rather worn female also in the American Museum. It expands 20 mm. The latter name was based on blackish specimens commonly found in populations of *pulchripennis* in which the typical red tones are suppressed. In many cases the condition seems due to rubbing and the removal of the red scaling of older individuals.

Life History and Habits

The larvae of *purchripennis* feed on the flowers and seeds of *Orthocarpus purpurascens* Benth. Eggs for rearing were obtained from females captured in Kirker Pass south of Pittsburg, Contra Costa Co., California, and in the San Antonio Valley in Santa Clara Co., California. Moths were also taken in copula on the blossoms of *Orthocarpus purpurascens* var. *ornatus* (Hel.) Jep., in the eastern Mojave Desert south of Red Mountain, San Bernardino County, California.

The moths rest and feed on the food plant. The rich velvet red or purple forewings marked with yellow fuse almost indistinguishably with the heads of the owlclover.

The species evidently has the ability to become locally very abundant. In the spring of 1952 moths were common in large areas of *Orthocarpus* in the San Antonio Valley. One large head which was picked and subsequently dissected contained 104 eggs of *pulchripennis*.

The eggs are usually deposited between the blossom and its enveloping bract, uncommonly within the blossom. Usually no great attempt is made to wedge the eggs deep within the head, and in most instances they are readily visible on superficial examination of the blossom.

The freshly hatched larvae feed sparingly, if at all, on the blossom and usually make their way directly to the seed capsule into which they burrow. The early instars commonly feed within the seed capsules. Fourth- and fifth-stadium larvae live openly on the head, feeding on both blossoms and seeds. The colour and maculation of the larvae probably afford considerable protection while feeding on the heads of the food plant.

Immature Stages[12]

Egg (Fig. 76).—Anterior surface weakly corrugated. Pale yellow when deposited, darkening to brownish-yellow during incubation. Head capsule and prothoracic shield becoming evident through chorion a few hours before hatching.

Primary cells regular in most specimens. Cells of second series generally well defined, mostly slender and elongate. Tertiaries evanescent in most instances. Cells of fourth and fifth series unmarked except by pores. Pores prominent, present at outer angles of cells of third, fourth, fifth and occasionally sixth series. In some instances, small pores present at outer angles of secondary cells. Mean diameter of primary rosette, .069 ± .007 mm.; mean number of primary cells, 16.5 ± 2.4 (26 eggs from 5 females).

Dimensions of egg: .70 ± .05 mm. x .54 ± .06 mm. (63 eggs from 6 females; San Diego; Byron, Contra Costa Co.; Mint Canyon, Los Angeles Co.; Burbank, Los Angeles Co.; Pittsburgh, Contra Costa Co., Calif.).

First-Stadium Larva.—Head medium to dark brown. Prothoracic shield, suranal shield and prolegs somewhat paler brown than head capsule. Spiracles with medium-brown rims. Trunk pale dirty yellow.

Head capsule width: 0.33 ± .01 mm. (30 larvae).

[12]For details of larval anatomy, see "Structure of the Larva", page 28.

Duration of stadium: 3.8 ± 0.9 days (10 larvae).

Second-Stadium Larva.—Head orange-brown to medium chocolate-brown. Prothoracic and suranal shields paler than head capsule, often with a greyish cast. Trunk pale greyish-yellow dorsally, often with a slight mauve tone. Spiracles with medium-brown rims. Ventral region greenish-grey, somewhat paler than dorsal region. Thoracic legs shades of brown.

Head capsule width: 0.48 ± .03 mm. (38 larvae).

Duration of stadium: 2.7 ± 1.5 days (10 larvae).

Third-Stadium Larva.—Head fawn-yellow to orange-brown. Many specimens with darker-brown mottling dorsally and laterally. In mottled specimens, usually a pair of pale arcs diverging upward and outward from centre of face. Prothoracic shield yellow-fawn to medium orange-brown with some darker-brown spotting. Pale yellow-fawn median and submarginal longitudinal lines often evident on prothoracic shield. Suranal shield essentially concolorous with, or somewhat paler than prothoracic shield.

Mid-dorsal band purplish-brown. Subdorsal area consisting of discontinuous, yellow marginal lines and a brown median band, somewhat paler than the mid-dorsal band. Supraspiracular area concolorous with median band of subdorsal area; lightly mottled with yellow. Spiracles with light- to medium-brown rims. Spiracular band dull yellow. Suprapodal area brownish-grey. Mid-ventral area dirty yellow-grey. Thoracic legs yellow or fawn. Body setae pale yellow or white.

Head capsule width: 0.71 ± .05 mm. (30 larvae).

Duration of stadium: 3.2 ± 2.5 days (10 larvae).

Fourth-Stadium Larva.—Head orange; in some specimens mottled dorsally and laterally with brown. A pair of arcs free of mottling diverging upward and outward from centre of face. Prothoracic shield fawn to brown, often darker than head capsule, in some specimens with a greyish cast. A median and a pair of submarginal pale-yellow longitudinal lines often evident on the prothoracic shield. Suranal shield greyish-fawn.

Mid-dorsal band from deep velvet-brown through purplish-brown to reddish-brown, paler on posterior half of each segment; intersegmentally constricted; bisected on meso- and meta-thorax by a pale-yellow line. Subdorsal area greenish-yellow with a median band of pale brown on meso- and meta-thorax; on abdominal segments, continuity of greenish-yellow broken by segmental patches of brown, paler than that of median band; brown area on each segment triangulate, the base of the triangle fusing with the brown of the supraspiracular area or separated from it by a narrow yellow line, and the apex fusing with the mid-dorsal band. Supraspiracular area concolorous with, or somewhat darker than, brown of subdorsal area; lightly mottled with pale yellow; with an irregular and discontinuous, pale yellow median longitudinal line. Spiracles with dark-brown rims. Spiracular band greenish-yellow. Suprapodal area brownish-grey. Mid-ventral area yellowish-grey. Thoracic legs yellow or fawn. Body setae very pale yellow or white.

Head capsule width: 1.04 ± .05 mm. (30 larvae).

Duration of stadium: 5.8 ± 1.0 days (10 larvae).

Fifth-Stadium Larva (Fig. 189).—Very similar to fourth instar. Head light orange-brown. Often mottled dorsally and laterally with somewhat darker brown. In mottled specimens usually a pair of pale arcs, free of mottling, diverging upward and outward from centre of face. Prothoracic shield medium to dark brown, with a median and a pair of submarginal longitudinal lines of pale yellow or fawn. Suranal shield light to medium fawn-brown.

Maculation of trunk complex. Mid-dorsal band from very dark brown, through purplish-brown to reddish-brown, paler on posterior half of each segment; intersegmentally constricted; often partially bisected on meso- and meta-thorax by an evanescent pale-yellow median line. Subdorsal area greenish-yellow with a light-brown median band on meso- and meta-thorax; on abdomen, each segment with roughly triangular patch, its base fusing or partially fusing with supraspiracular area and its apex fusing in middle of segment with mid-dorsal band. Supraspiracular area concolorous with brown of sub-dorsal area, lightly mottled with greenish-yellow, and with a discontinuous and irregular median longitudinal line. Spiracles with dark-brown rims. Spiracular band conspicuous greenish-yellow. Suprapodal area brownish-grey. Mid-ventral area pale grey. Thoracic legs fawn-yellow. Body setae fawn or light brown, darker than those of fourth instar.

Head capsule width: 1.65 ± .05 mm. (30 larvae).

Duration of stadium: 5.0 ± 1.0 days (10 larvae).

Pupa (Figs. 122-124).—Relatively stout, heavily sclerotized. Medium orange-brown. Mesothoracic legs relatively short in comparison with length of proboscis, similar in relative length to those of *triolata*. Visible distal portions of metathoracic legs similar in size to those of *triolata*. Seta L2 absent from surface of fourth abdominal segment. Slight, inconspicuous dimpling near anterior margin of dorsum of fourth abdominal. Pitting on abdominal segments five to seven moderately heavy, confined to anterior half of segment. Cremaster consisting of two closely appressed, ventrally curving spines; spines stouter than those of other species considered, approximating those of *triolata* in length.

Length to posterior margin of fourth abdominal segment: 6.8 ± 0.5 mm. (17 pupae).

SCHINIA SCISSA (GROTE)

Fig. 173

1876. Grote, Proc. Bost. Soc. Nat. Hist. 18: 415; *Lygranthoecia.*
1883. Smith, Trans. Am. Ent. Soc. 10: 252; *Schinia.*
1890. Grote, Check List, p. 36; *Canidia.*
1893. Smith, Bull. U.S. Nat. Mus. 44: 285; *Schinia.*
1903. Hampson, Cat. Lep. Phal. 4: 17; *Heliothis.*
1903. Holland, Moth Book, p. 226; *Canidia.*
1927. Draudt, Groszschmett. der Erde 7: 331; *Melicleptria.*

Forewing chocolate-brown suffused with red. Hind wing yellow with broad brown border and prominent discal spot.

Head and thorax dark-scaled; thorax overlaid with reddish-brown hair. Abdomen dark-brown with yellow rings at termini of segments and with yellow anal tuft. Beneath, vestiture of body grey suffused with red.

No transverse anterior line evident on forewing. Basal half of wing dark brown suffused with reddish-brown. Transverse posterior line dark brown, weakly emarginated outwardly by a line of pale scaling; deeply excurved opposite cell, then essentially straight from a point immediately below reniform to inner margin. A pale-grey triangle suffused with reddish-brown scaling proximal to arc of t.p. line, representing the anterior portion of the median space. An elongate dark reniform in pale portion of median space. Posterior portion of median space dark brown suffused with reddish-brown and indistinguishably fused with basal space. Subterminal line absent. Area distal to t.p. line a uniform reddish-brown, somewhat paler than basal area of wing. Fringe concolorous with terminal area of wing.

Hind wing bright yellow centrally. A dark-brown, outer marginal band, and a narrower, brown, inner marginal band. A large, dark-brown discal spot in centre of yellow area.

Beneath, both wings yellow marked with brown and red. Forewing with extensive brown basal area except for a narrow yellow band along inner margin. Median area of wing yellow, containing the large, dark-brown discal spot. Apex of wing red. A broad, brown, outer marginal band posterior to apical red area. Hind wing bright yellow centrally, containing prominent dark-brown discal spot. Base and inner margin of wing chocolate-brown. A broad outer marginal band posterior to red at apex of wing.

Expanse: 18 mm.

Foretibia (Fig. 18a) with four or five inner spines and four outer spines in the few specimens examined. Abdominal brushes absent in single male examined.

Male Genitalia (Fig. 38).—Valve moderately narrow, with usual marginal setae on valve but without evident corona. Ampulla unusually long and slender. Uncus long, slender, tapering from base to apex. Juxta shallow dorso-ventrally, with slight lateral prominences. Vesica without basal diverticulum.

Female Genitalia (Figs. 52a, 69a).—Valve of ovipositor sharply rounded apically, well clothed with minute setae. Intersegmental membrane anterior to valve sclerotized ventrally. Penultimate segment with heavy covering of elongate, slender spicules. Bursa without signa in specimens examined.

Type Material.—The type, taken at Appalachicola, Florida, is a male in the British Museum (Natural History). It is rather rubbed but is in generally fair condition. It expands 18 mm.

To my knowledge, there are only four specimens of this species in collections: the type, a single male in the United States National Museum, and two females in the Museum of Comparative Zoology. The latter three specimens lack locality data, and the male in the United States National Museum is without head.

SCHINIA AVEMENSIS (DYAR)

Fig. 174

1904. Dyar, J. N.Y. Ent. Soc. 12: 41; *Pseudotamila.*
1913. Barnes & McDunnough, Contrib. Nat. Hist. Lep. N.A. 2(1): 10.
1927. Draudt, Groszchmett. der Erde 7: 333.

Maculation of forewing unusual and complex, yellow and brown mixed in streaks and patches. Hind wing uniform light brown.

Head pale yellow in most specimens. Thorax with mixed yellow and brown vestiture. Abdomen with dull-brown scaling except for yellow terminus. Beneath, head and anterior portion of thorax pale yellow; remainder of under surface of body dull brown.

Transverse anterior line of forewing irregular, consisting of three outwardly directed Vs, the middle of these, extending over the median vein, being the most prominent; the anterior one the least prominent. Costal portion of t.a. line usually somewhat thicker than remainder. Basal space medium dark brown, with admixture of pale-yellow scaling. A short basal line between costal and median veins. Area proximal to this line paler than remainder of basal space. Transverse posterior line deeply excurved for anterior two-thirds of its length, then sinuate to trailing margin; dentate anteriorly; widest at costal and trailing margins. Median space more heavily suffused with yellow than basal space. Reniform represented by two closely associated black dots,

sometimes connected by a black line. Usually a subcostal yellow dash extending from t.a. line to reniform spots. Subterminal line sinuate, marked only by colour change between terminal and subterminal areas. Subterminal space darker than median space, bisected by outward arc of t.p. line. Terminal space yellow with some brown scaling along the veins. A series of brown, intervenal, terminal lunules. Fringe usually very pale brown inwardly, and yellow outwardly.

Hind wing uniform chocolate-brown, usually with a darker marginal line. Fringe concolorous with wing.

Beneath, forewing chocolate-brown with pale-yellow apex and outer marginal band. A series of brown terminal dashes in the outer yellow band. Fringe yellow. Hind wing chocolate-brown with concolorous fringe. Often a very small area of yellow at apex of hind wing.

Expanse: 17.1 ± 1.5 mm. (17 specimens).

Foretibia (Fig. 18) commonly armed with two inner and three or four outer, in most cases, slender spines. Male without abdominal brushes.

Male Genitalia (Fig. 34).—Valve broad, short and flat. Corona consisting of about a dozen setae arranged at extreme apical margin of valve. Ampulla reduced to a slight flap. Juxta with straight dorsal and ventral margins and with short lateral points. Anellus with small quadrate sclerotized plates. Uncus long, slender, tapering from base to apex. Vesica without evident basal diverticulum.

Female Genitalia (Figs. 54, 71).—Valve of ovipositor broadly rounded apically and with a broad, sclerotized anterior extension, ventrally. Valve rather sparsely clothed with short, slender setae, most heavily clothed at apical margin; a number of elongate setae. Penultimate segment covered with minute spicules.

Distribution and Period of Flight.—The species is recorded only from Aweme, Treesbank, and Onah, Manitoba. Specimens examined were taken between July 22 and August 1.

Type Material.—The type of *avemensis* (Type No. 7734) is in the United States National Museum. The specimen is a male in excellent condition; it has a golden cast to the forewing not found in most specimens. It expands 14 mm.

The life history of the species is unknown.

SCHINIA MITIS (GROTE)

Fig. 175

1873. Grote, Bull. Buff. Soc. Nat. Sci. 1: 116; *Heliothis.*
1875. Grote, Bull. Buff. Soc. Nat. Sci. 2: 220; *Heliophana.*
1883. Smith, Trans. Am. Ent. Soc. 10: 240.
1893. Smith, Bull. U.S. Nat. Mus. 44: 290.
1903. Hampson, Cat. Lep. Phal. 4: 14.
1903. Holland, Moth Book, p. 230.
1927. Draudt, Groszschmett. der Erde 7: 331.

obliquata (Smith)
1891. Smith, Trans. Am. Ent. Soc. 18: 130; *Heliophana.*
1893. Smith, Bull. U.S. Nat. Mus. 44: 290; sunk to *mitis.*

Maculation variable. Forewing orange-fawn, marked with brown and variably suffused with grey. Hind wing chocolate-brown.

Vestiture of head and thorax fawn, olive-tinged in many specimens. Abdomen greyish-brown with lines of yellow at posterior margins of segments. A pale anal tuft. Beneath, head and thorax greyish-fawn; abdomen grey-brown.

Anterior half of transverse anterior line essentially parallel to costal margin; extending outward from a point posterior to base of subcostal vein to a point near centre of wing, then abruptly changing course and angling basally and posteriorly to trailing margin close to base. In most specimens t.a. marked only by colour change, in very dark specimens evident as a pale line. Basal triangle of wing orange-fawn suffused with grey, especially at immediate base of wing. Costal band anterior to basal triangle of wing concolorous with median space. Transverse posterior line marked only by colour change, or evident as a pale narrow line in very dark specimens; briefly excurved at costal margin near apex, then angling inwardly to a point somewhat beyond the middle of the trailing margin. Median area constricted, yellow-fawn. Median and basal spaces of forewing often suffused with chocolate-brown, reddish-purple, or grey, occasionally so heavily so as to obscure maculation. Reniform beyond apex of basal triangle, elongate, slender, scarcely discernible in many specimens. Subterminal line irregular, marked only by colour change, often weakly sinuate, curving in from apex, anteriorly and out to outer angle posteriorly. Subterminal space generally narrow, concolorous with basal space. Terminal space yellow-fawn. A dark-brown terminal line in most specimens. Fringe concolorous with terminal space.

In many specimens hind wing uniform dark brown, but generally the inner third of wing considerably paler than remainder. Fringe pale yellow.

Beneath, both fore- and hind wings light brown with yellow apical and costal areas.

Expanse: 18.6 ± 1.7 mm. (86 specimens).

Foretibia (Fig. 19) armed with two inner terminal claws. In addition to these, commonly two or three slender inner spines and three or four outer spines. Abdominal brushes absent in male.

Male Genitalia (Fig. 36).—Valve relatively broad and flat. Corona consisting of from 20 to 25 slender spines at apical margin of valve. Ampulla absent. Uncus tapering from base to apex. Juxta with rounded lateral and ventral margins, narrower dorsally than ventrally. Vesica slender, weakly coiled.

Female Genitalia (Figs. 55, 72).—Ovipositor slender, extremely long. Valve with a moderate clothing of slender setae; sharply rounded apically. A number of setae on intersegmental membrane anterior to valve. Penultimate segment heavily clothed with very coarse spicules. Vesica without signa in specimens examined.

Distribution (Fig. 144) *and Period of Flight.*—The species ranges from central Florida, north to Georgia, and west to eastern Texas. The species is evidently double-brooded. The majority of specimens examined were taken in April, May and June. A few of the moths seen, however, were collected in September and November.

Type Material.—Grote's type of *mitis* is in the British Museum. It was taken in "central Alabama". The type of *obliquata* Sm. (Type No. 33705), is in the United States National Museum. It is a male in generally excellent condition, although both front legs are absent. Smith's type, collected in Texas, is orange-fawn but the basal half of the forewing is suffused with grey. It expands 18 mm.

Florida specimens of this species tend to be smaller and darker than specimens from other localities. Forbes (1954) records the food plant of the species as *Sitilias caroliniana* Walt.

Immature Stages

Egg (Fig. 84).—Primary cells irregular in many cases. Secondary and tertiary cells well-defined. Cells of fourth and fifth series variably defined, usually poorly so. Pores very small and inconspicuous, commonly present at angles of cells between third and fifth, sixth or seventh series. Mean diameter of primary rosette, .056 ± .006 mm.; mean number of primary cells, 13.1 ± 1.7 (18 eggs from 3 females).

Dimensions of egg: .75 ± .06 mm. x .56 ± .05 mm. (67 eggs from 4 females; Alexandria, La.; Orlando, Fla.; St. Simon Is., Ga.; Arkansas).

SCHINIA CARMINATRA (SMITH)

Fig. 176

1903. Smith, Trans. Am. Ent. Soc. 29: 207; *Pseudotamila.*
1927. Draudt, Groszschmett. der Erde 7: 333.

Forewing varying from dull coppery-red to dark fawn-grey. Hind wing dark chocolate-brown.

Vestiture of head pale fawn. Thoracic vestiture concolorous with forewing. Abdomen dull brown with pale rings at posterior margins of segments and with yellow terminal tuft. Underside of head and prothorax largely pale fawn, remainder of underside of body dark brown or grey.

Transverse anterior line broad, dark brown, broadly excurved. In many specimens, t.a. margined inwardly by a line of white scaling. Basal area usually somewhat darker than other regions of the wing. Anterior two-thirds of transverse posterior line broadly excurved, remainder essentially straight to trailing margin, dark brown, dentate along veins, margined outwardly by a line of white scaling. Median area dark brown along costal and trailing margins; remainder paler than basal space. Reniform small, dark brown, poorly defined. Subterminal line absent. A dark-brown terminal line. Fringe of ground colour inwardly; paler, almost white outwardly.

Hind wing uniform dark chocolate-brown. Fringe brown inwardly, white outwardly.

Beneath, forewing white, marked with brown bands and patches; very striking and characteristic maculation. An elongate brown triangle at base of wing between costal and median veins. A brown reniform in white median area. A brown outer marginal band, then a white sugmarginal band basal to which is another brown band. Fringe concolorous with terminal band inwardly, becoming somewhat paler outwardly. Hind wing dark cholocate-brown. Fringe concolorous inwardly, practically white outwardly.

Expanse: 16.2 ± 1.2 mm. (14 specimens).

Foretibia (Fig. 20) commonly armed with one relatively stout inner terminal claw and two shorter outer spines. Male without abdominal brushes.

Male Genitalia (Fig. 38).—Valve relatively short, broad and flat. Corona consisting of about ten fine setae arranged along the apical margin of valve. Ampulla long and moderately stout. Uncus long and slender. Juxta broadly diamond-shaped, tapering to a broad point both ventrally and dorsally. Anellus with a pair of elongate sclerotized rods. Vesica with basal pouch reflexed but without diverticulum.

Female Genitalia (Figs. 56, 73).—Valve of ovipositor triangulate, rounded apically; with a moderate covering of short setae and a number of elongate slender ones. Penultimate segment clothed with elongate, coarse spicules.

Distribution and Period of Flight.—The species has been taken only in central Colorado. Specimens examined with more exact locality labels were

taken at Denver, Walsenburg and La Junta. Only one specimen, collected on June 14, was labelled as to date of capture.

Type Material.—There are a male and a female specimen labelled "type" at the American Museum of Natural History. They were taken in "Colorado" at an elevation of 6,000 feet. The specimens are in generally good condition but both are thoracically "scalped". The male, which lacks one antenna, is here selected as lectotype. It is pale fawn except for a somewhat darker basal area, and expands 16 mm. In addition to these specimens, there are also two "cotypes" at the American Museum.

The food plant and immature stages of the species are unknown.

MELICLEPTRIA GRAEFIANA TEPPER

1927. Draudt, Groszschmett. der Erde 7: 331; *Melicleptria.*

It has not been possible to determine the identity of this species. There is a specimen of *Schinia triolata* (Sm.) in the United States National Museum (Type No. 33703) labelled type of *Melicleptria graefiana.* The forewing of this female specimen is grey suffused with pale rust-brown, and with pale-grey and white median space. The hind wing is white with a broad, dark-brown band. The specimen is labelled merely "So. Cal.". If this be the true type of *graefiana,* then Tepper's original description is inaccurate and misleading. The forewing is not vinous red and the hind wing is not yellow.

In the Tepper Collection at East Lansing there are three specimens of *Schinia pulchripennis* (Grt.) above what is evidently Tepper's original label for *graefiana.* All of these specimens are recorded as being taken in southern California but none of them is labelled type.

The original description of the species is reproduced here:

"A very pretty species, closely allied to *pulchripennis,* but differing from it and all other species in the genus by the yellow secondaries margined all around with black, and having a large black discal spot; the primaries are of a rather pale vinous red, with pale grey outer margin and wide yellow median shade in which are the large reniform and orbicular. Expands 7/8 inch, 22 mm. Habitat:—Southern California."

If the specimen in the United States National Museum is the true type of this species, then Smith's and Tepper's names are synonymous, and *graefiana* has priority over *triolata.*

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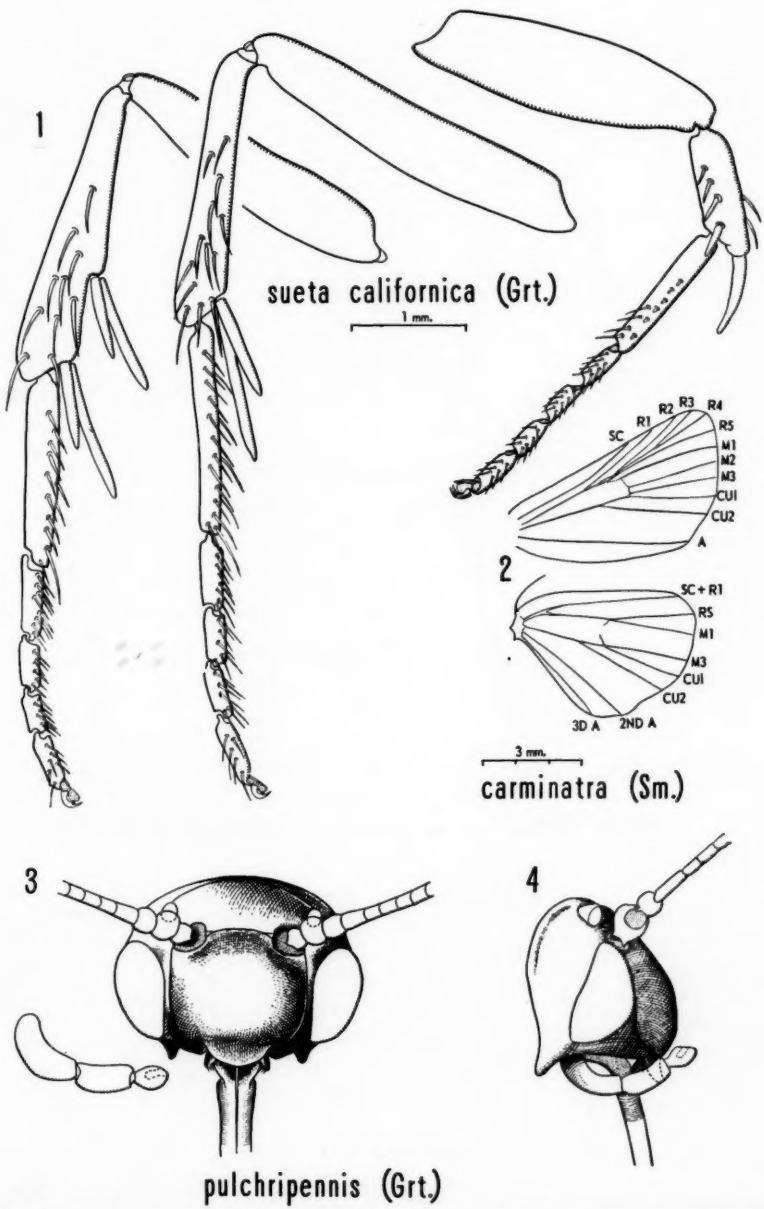
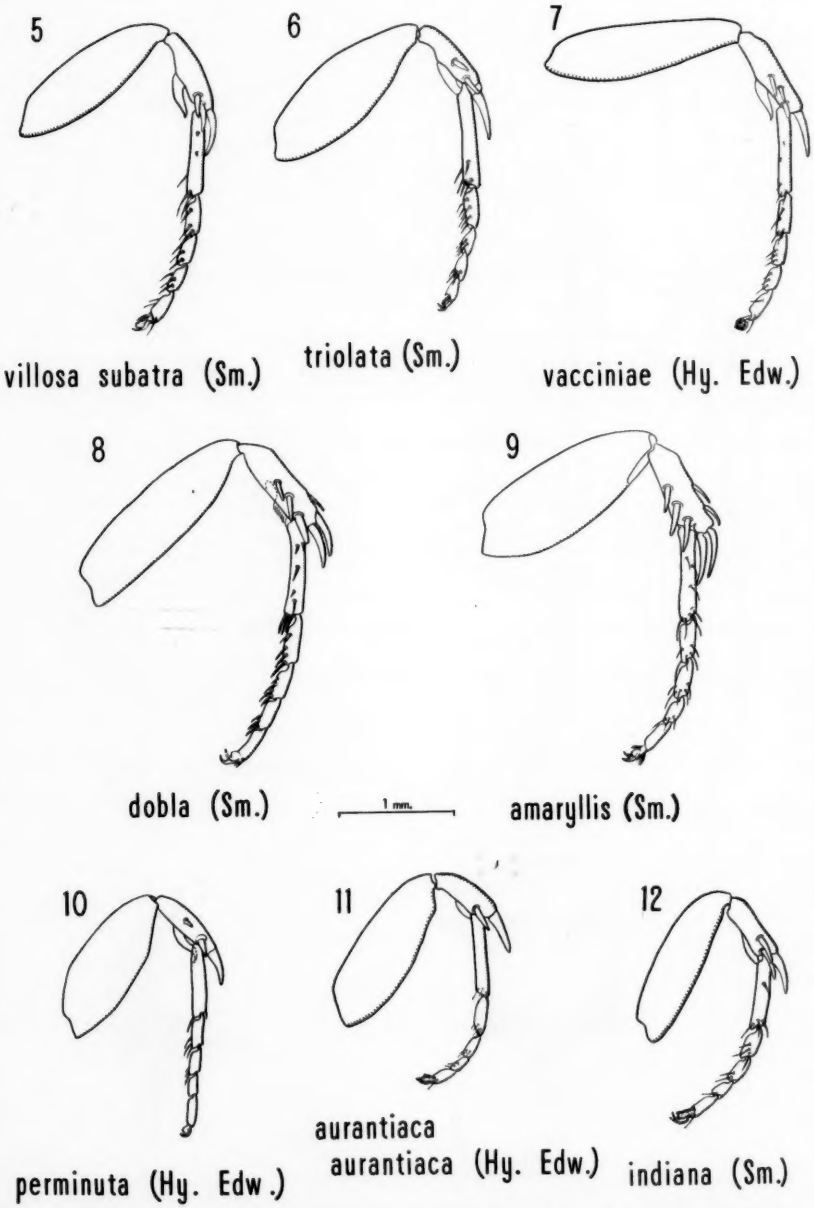
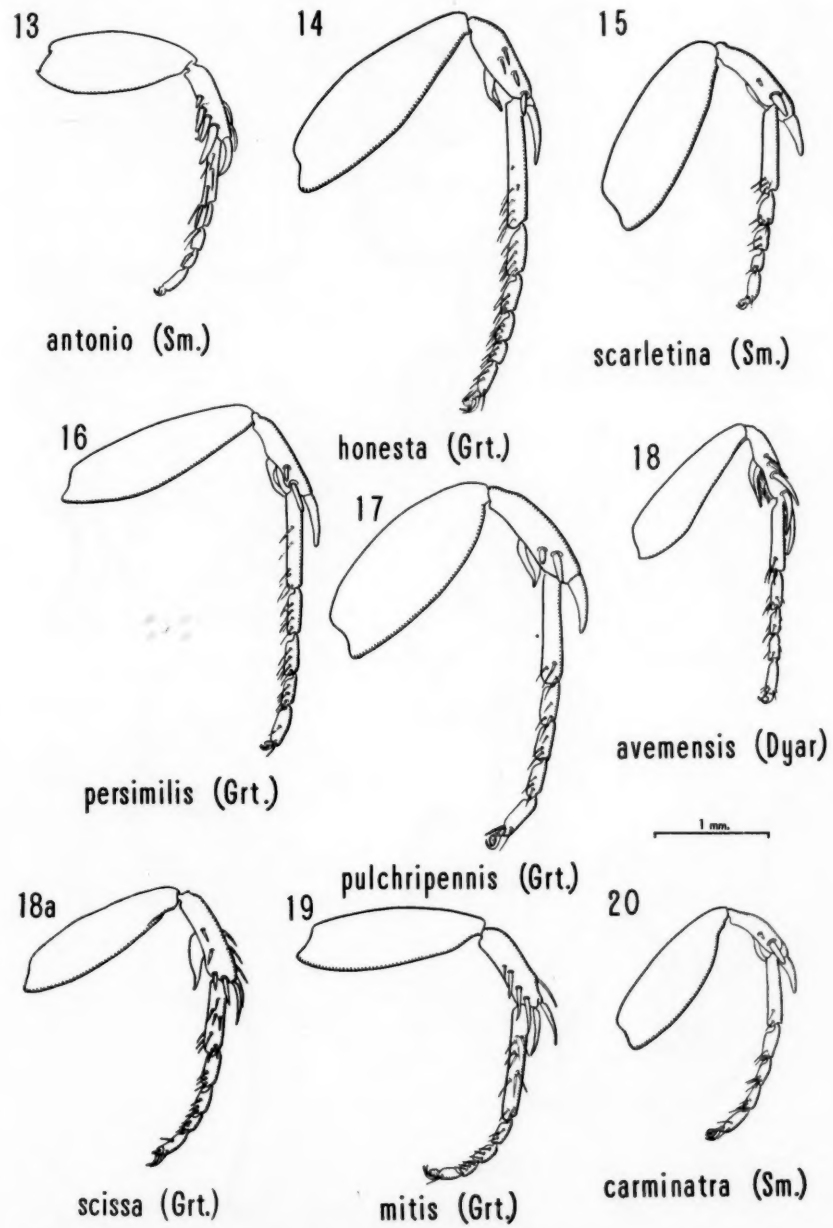


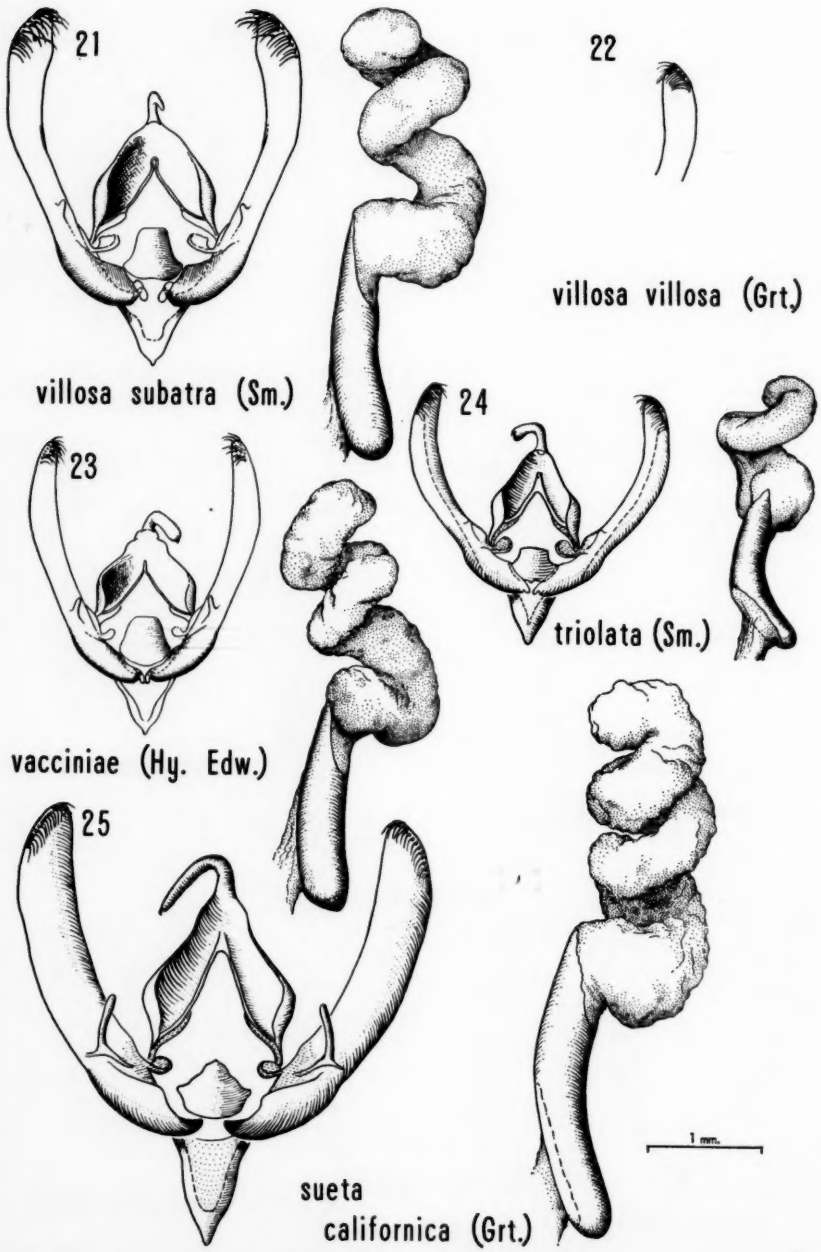
Figs. 1-4. *Schinia* spp. 1, Lateral aspect of right legs of adult. 2, Wing venation. 3, 4, Anterior and right lateral aspects of head of adult.



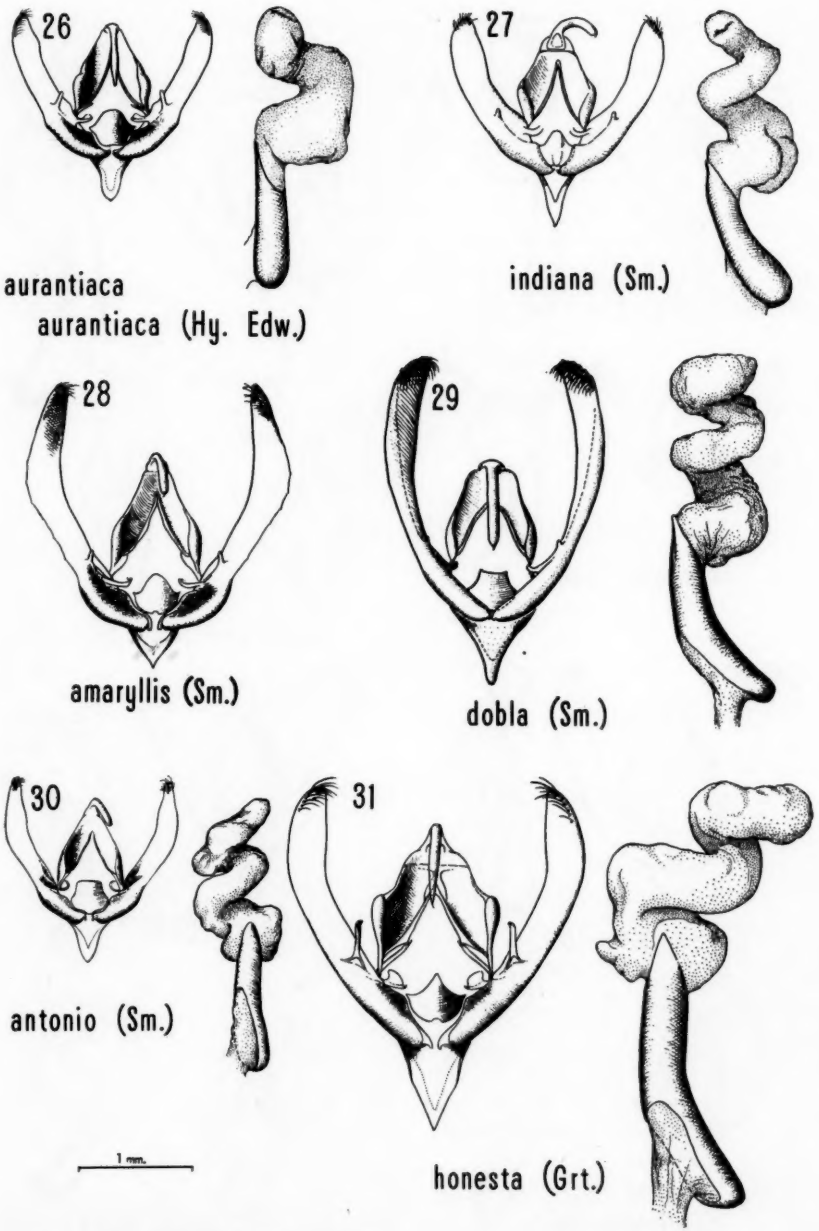
Figs. 5-12. *Schinia* spp. Lateral aspects of right front legs.



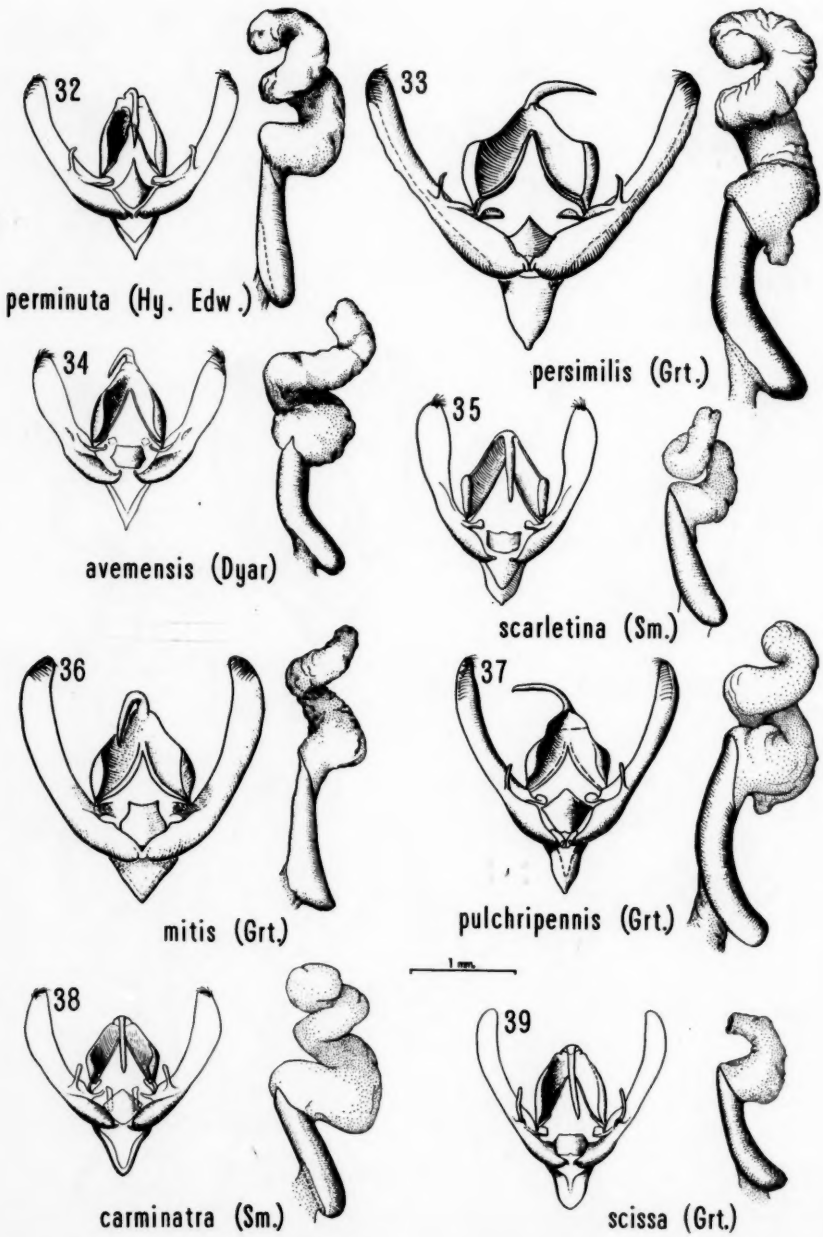
Figs. 13-20. *Schinia* spp. Lateral aspects of right front legs.



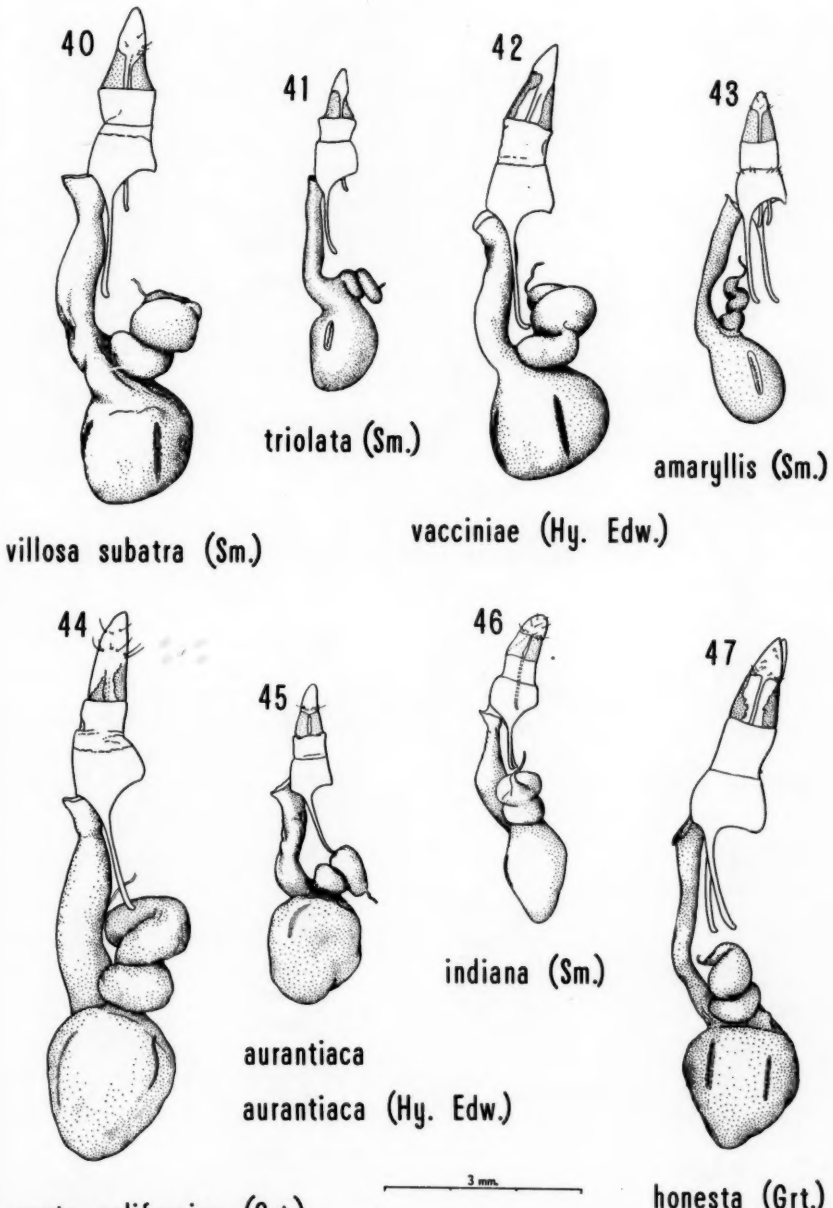
Figs. 21-25. *Schinia* spp. Male genitalia.



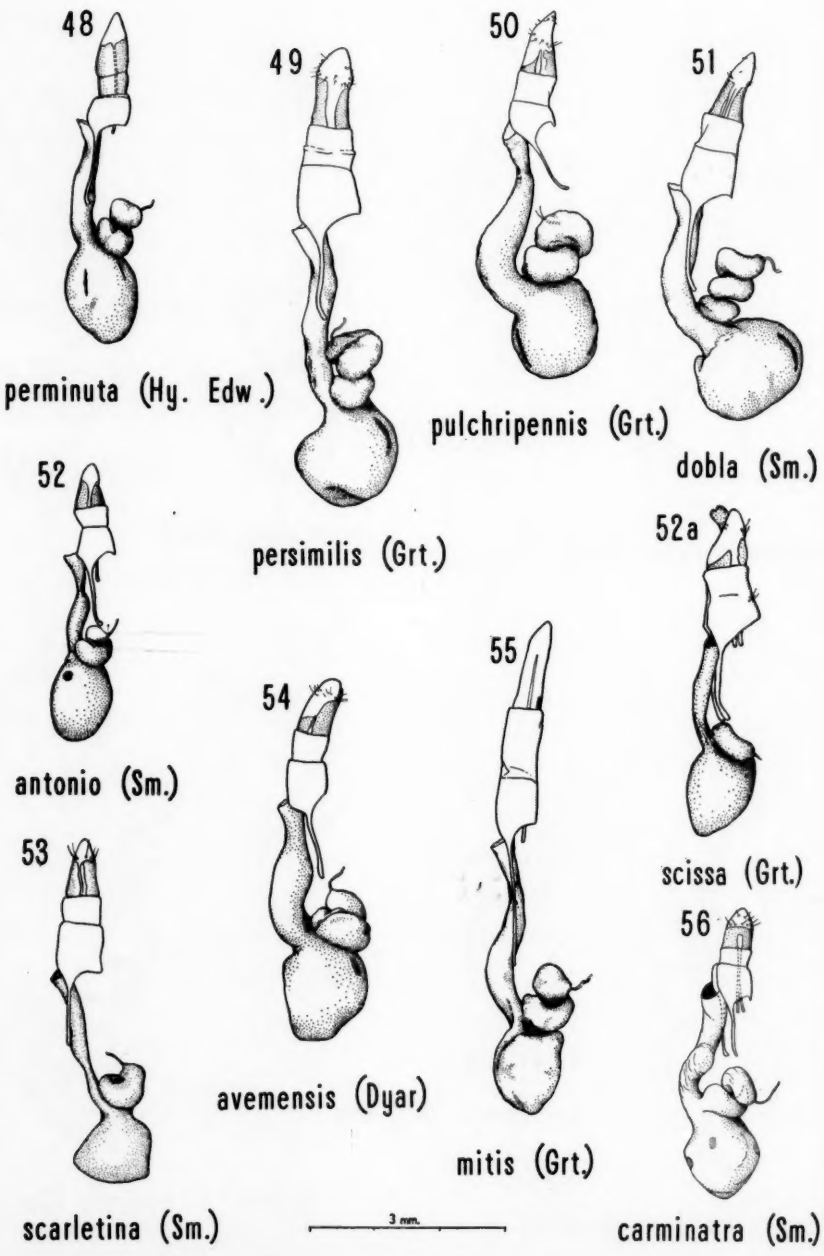
Figs. 26-31. *Schinia* spp. Male genitalia.



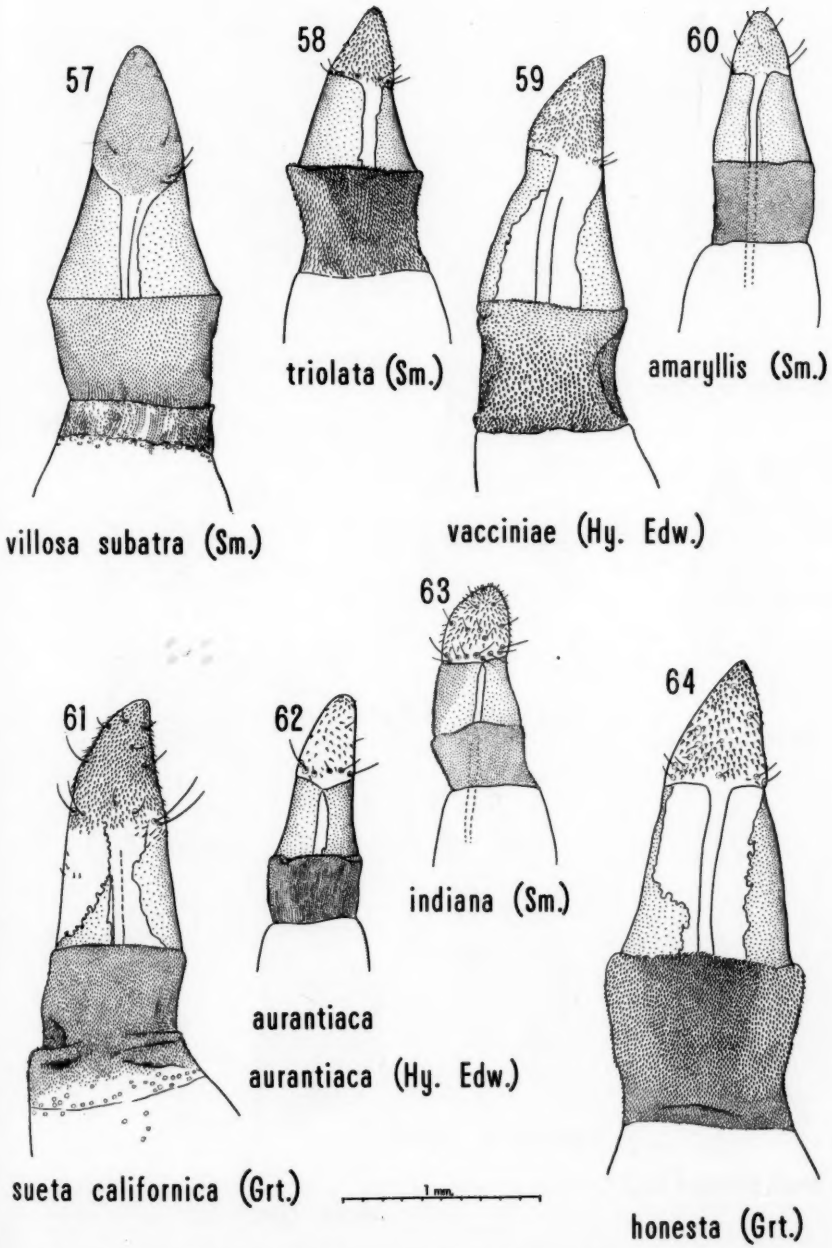
Figs. 32-39. *Schinia* spp. Male genitalia.



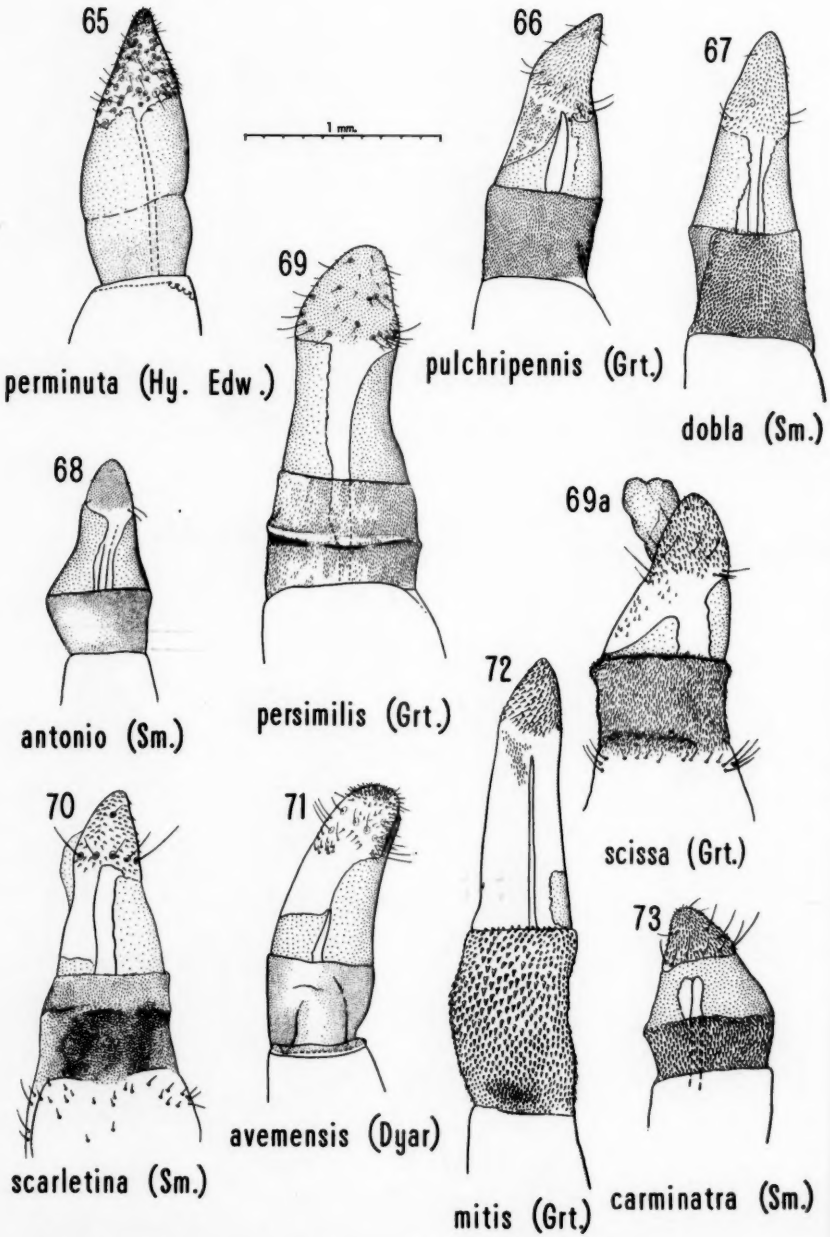
Figs. 40-47. *Schinia* spp. Female genitalia.



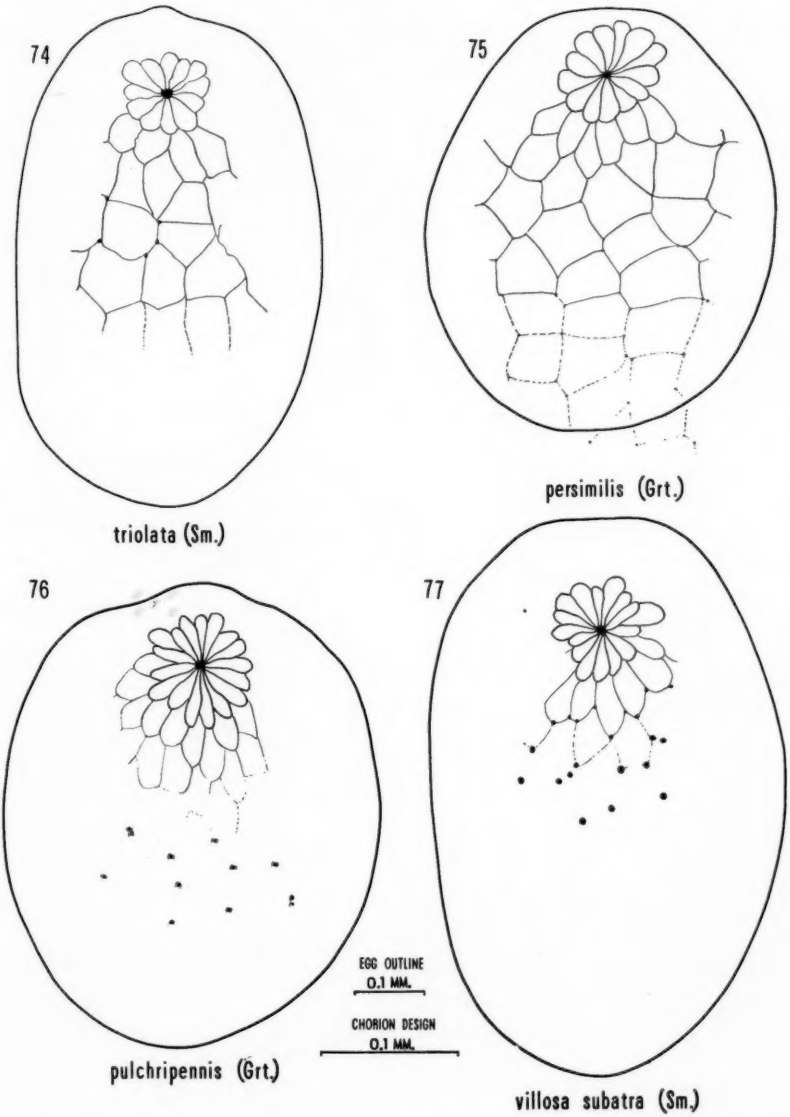
Figs. 48-56. *Schinia* spp. Female genitalia.



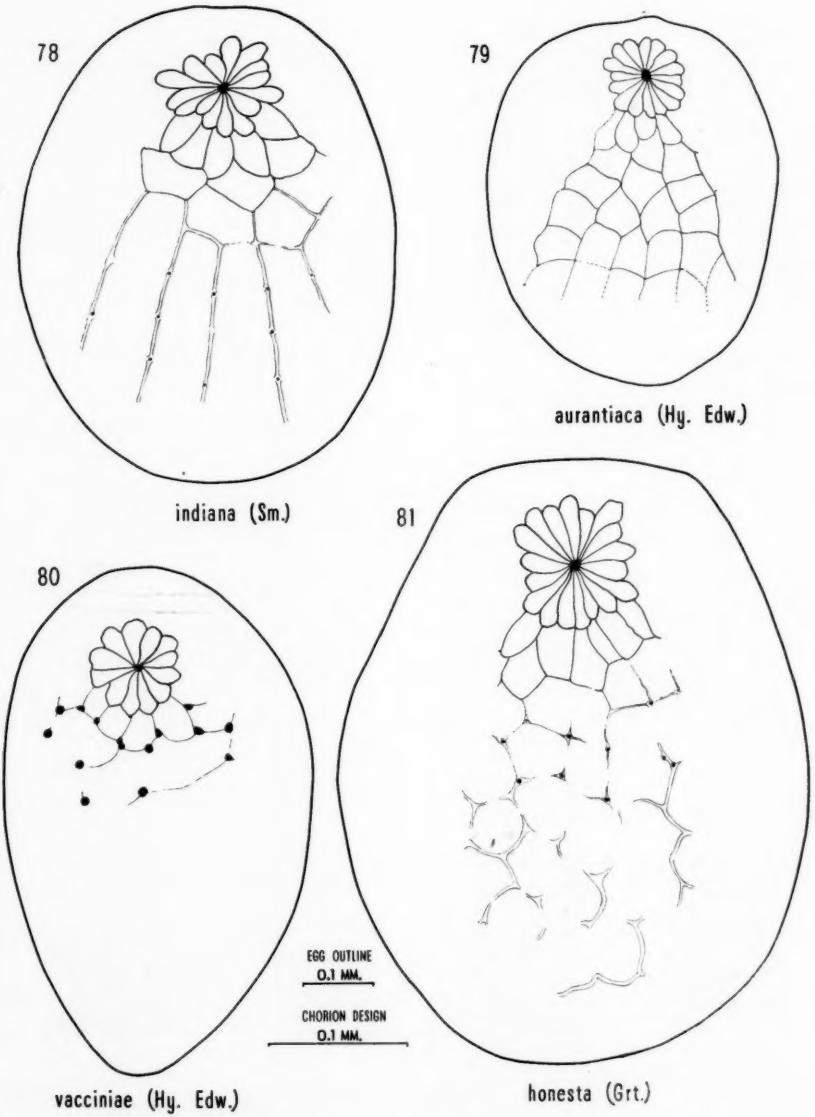
Figs. 57-64. *Schinia* spp. Apical segments of female abdomens.



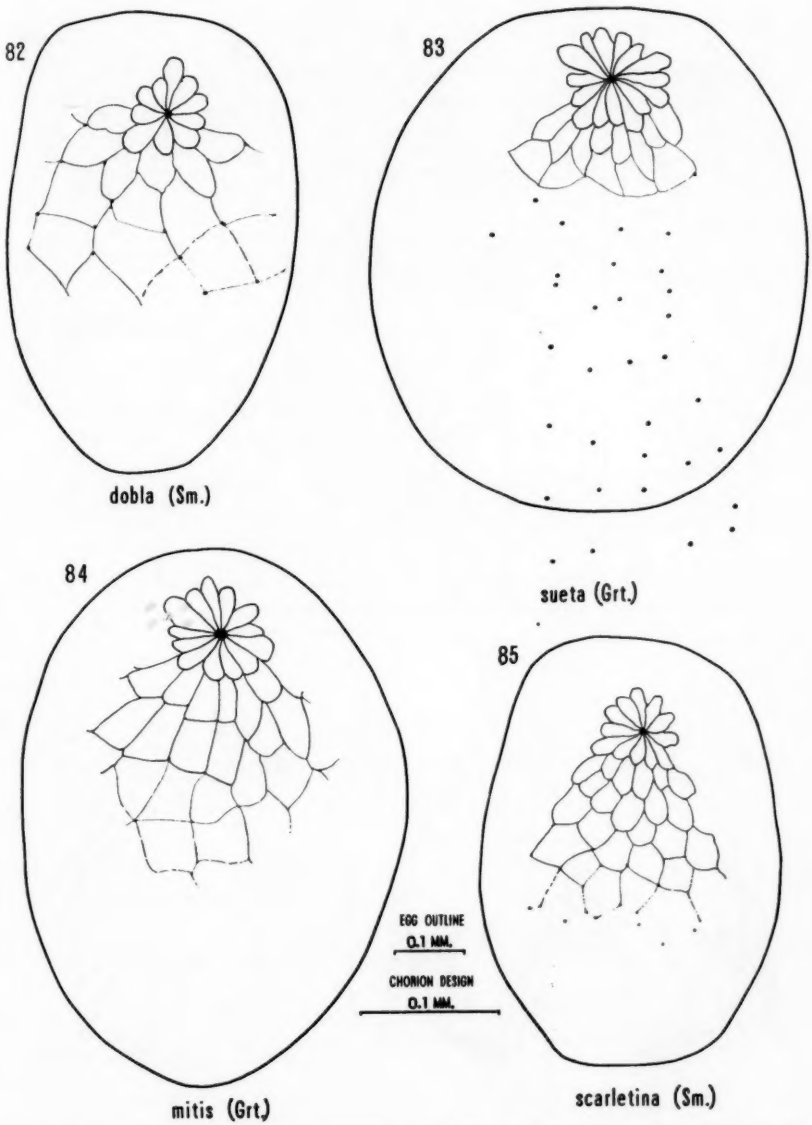
Figs. 65-73. *Schinia* spp. Apical segments of female abdomens.



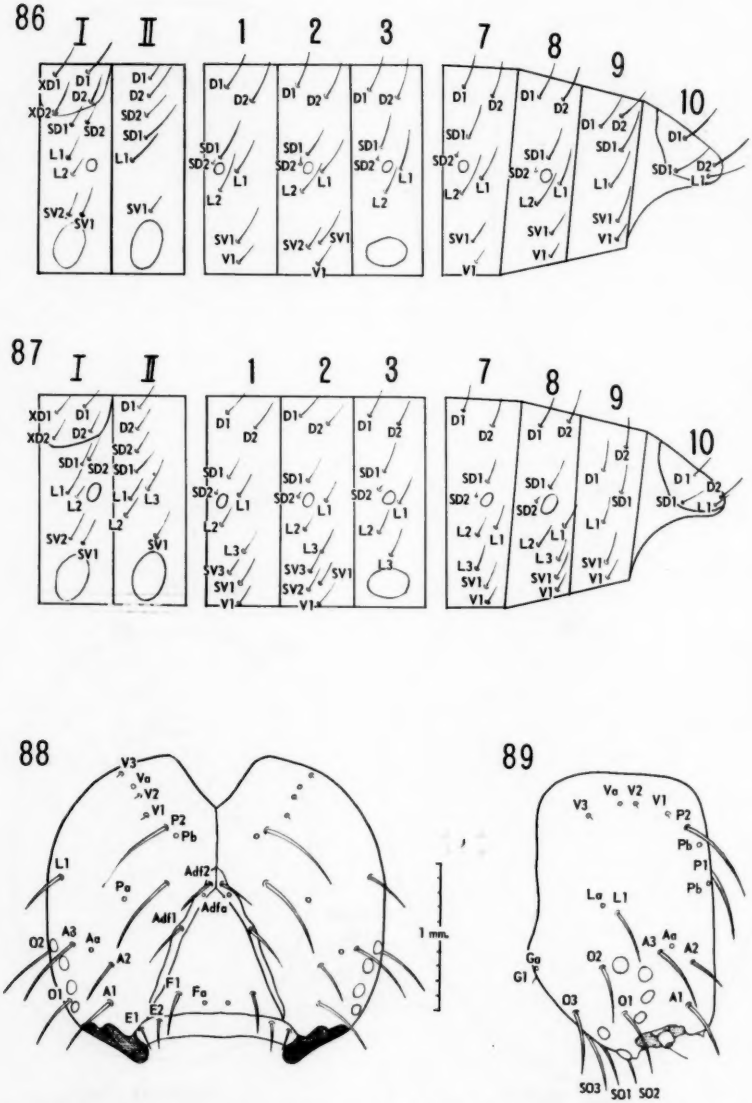
Figs. 74-77. *Schinia* spp. Lateral aspects and chorion designs of eggs. Chorion designs at twice the scale of eggs and not in natural position.



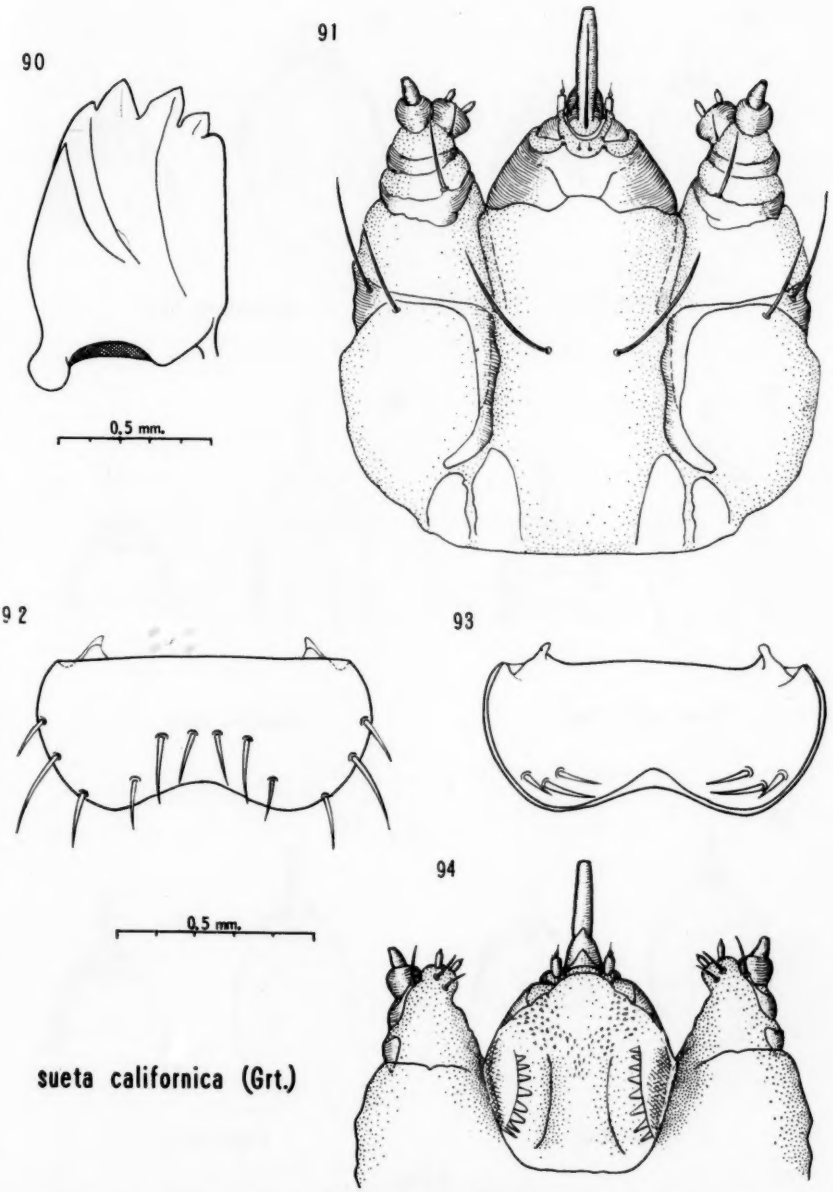
Figs. 78-81. *Schinia* spp. Lateral aspects and chorion designs of eggs. Chorion designs at twice the scale of eggs and not in natural position.



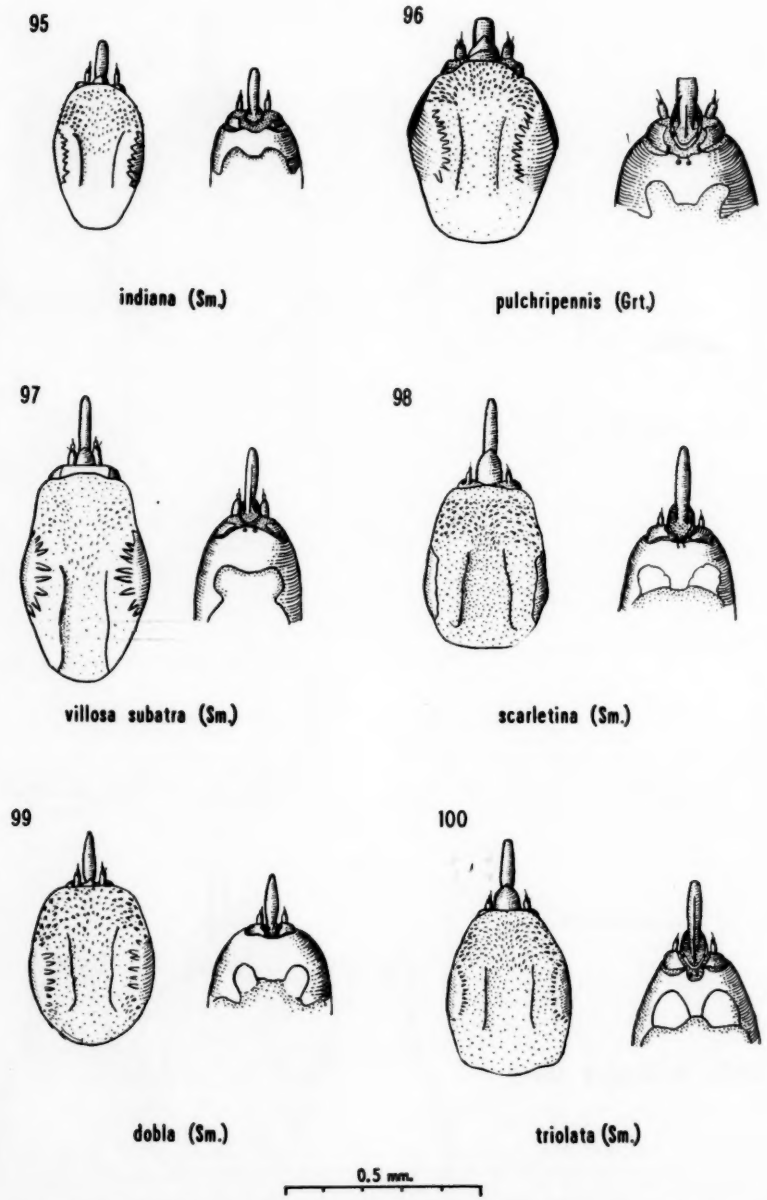
Figs. 82-85. *Schinia* spp. Lateral aspects and chorion designs of eggs. Chorion designs at twice the scale of eggs and not in natural position.



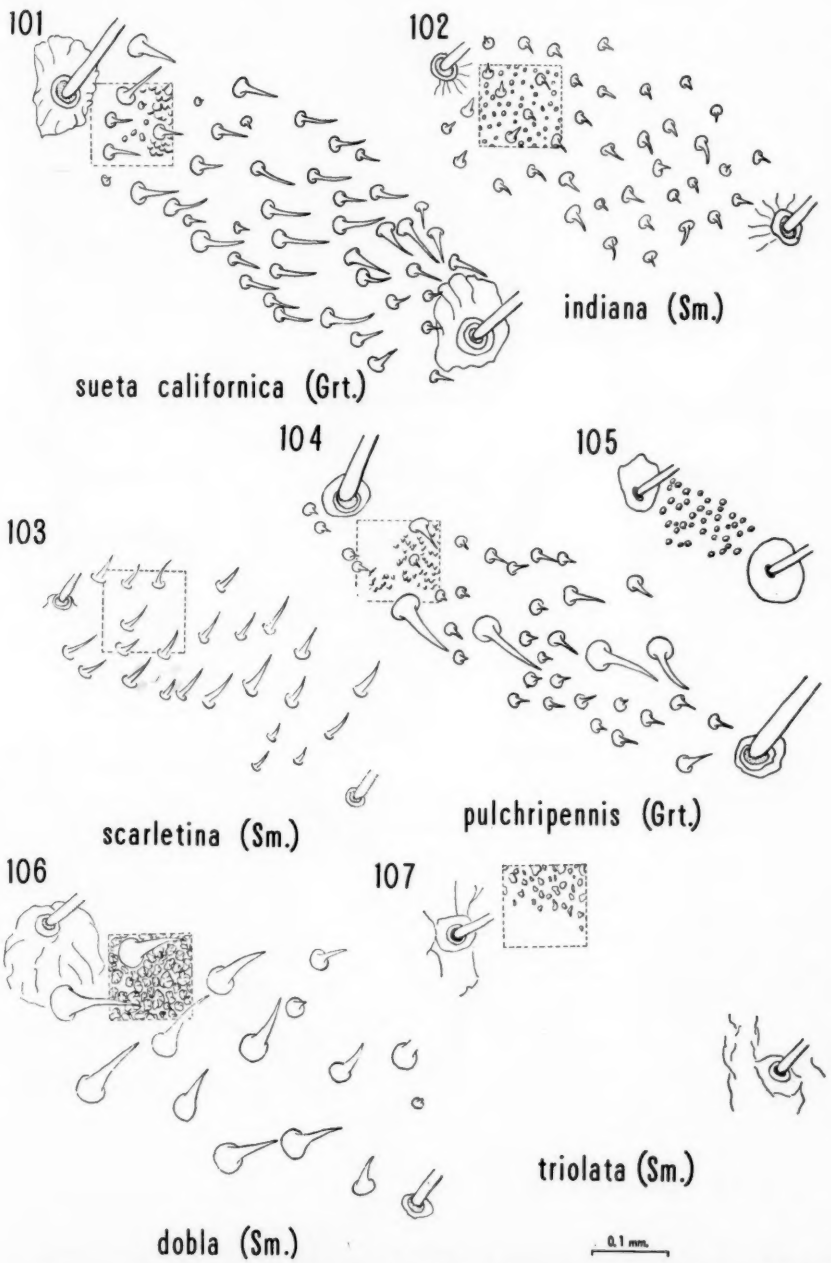
Figs. 86-89. *Schinia sueta californica* (Grt.). 86, Setal map of first-stadium larva. 87, Setal map of fifth-stadium larva. 88, 89, Setal maps of head of fifth-stadium larva.



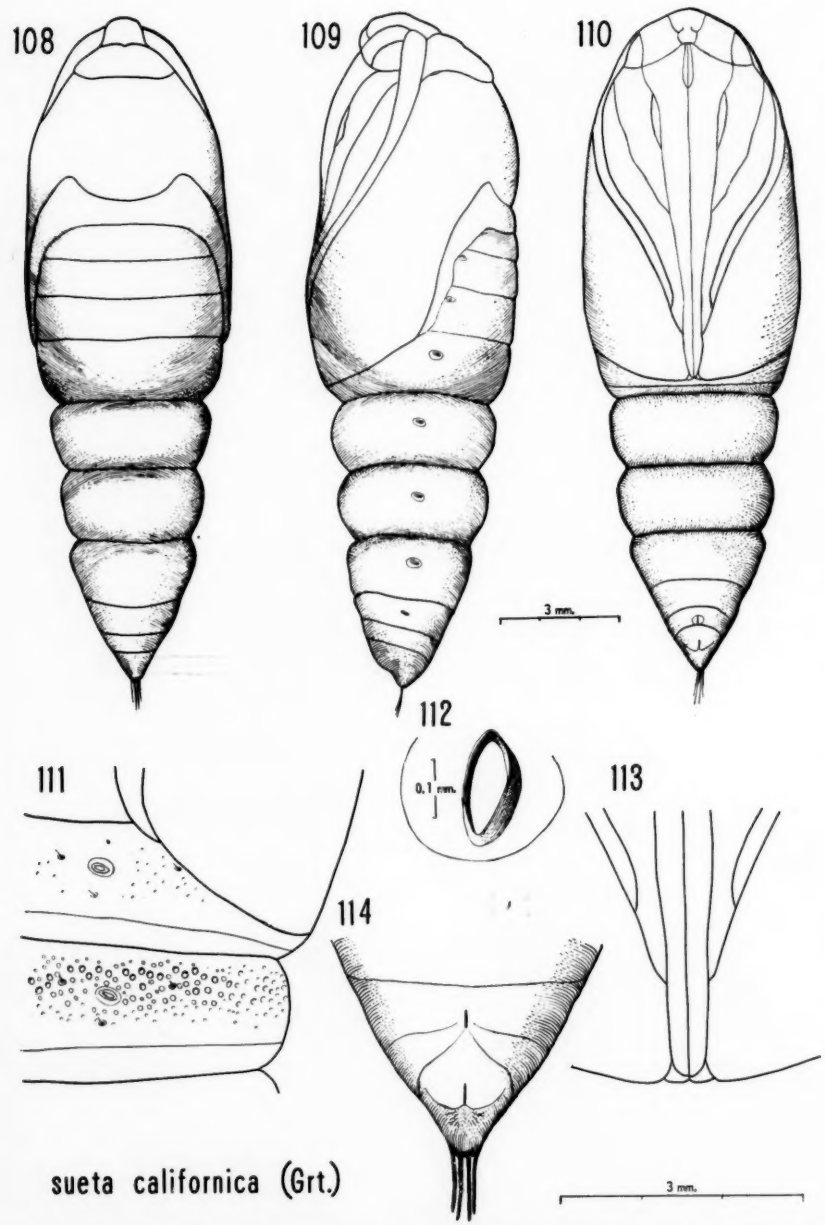
Figs. 90-94. *Schinia sueta californica* (Grt.). 90, Oral aspect of right mandible. 91, 94, Oral and ventral aspects of lower lip complex. 92, 93, Anterior and oral aspects of labrum.



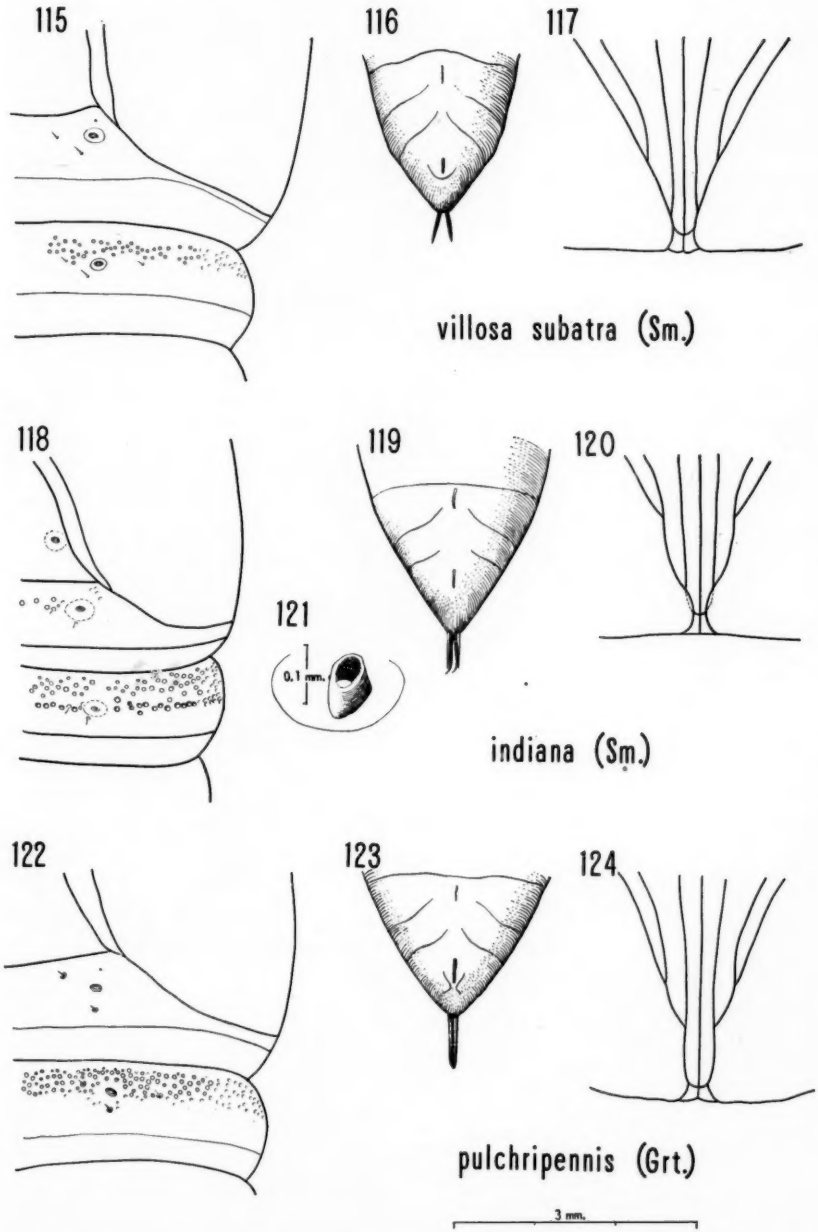
Figs. 95-100. *Schinia* spp. Oral and ventral aspects of lower lip complexes.



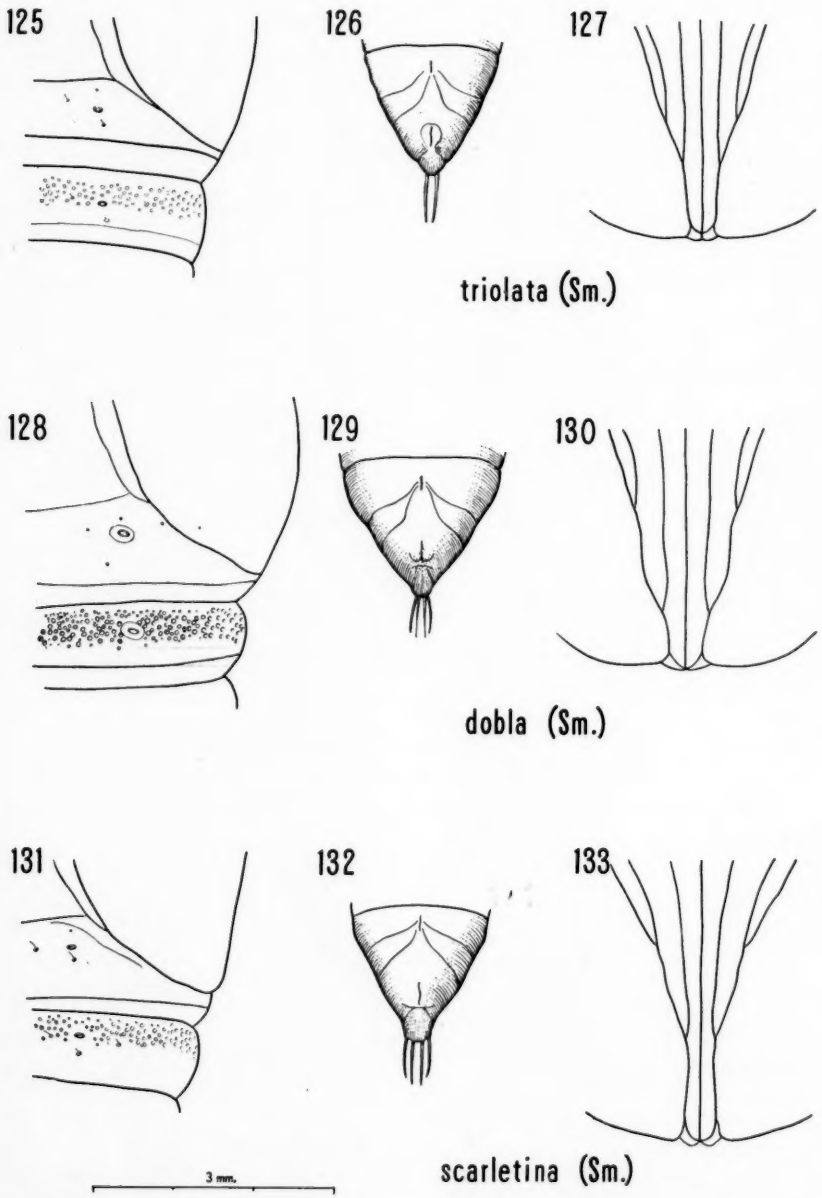
Figs. 101-107. Texture and spiculation of skin of *Schinia* spp. between setae D1 and D2 of first abdominal segment of first-stadium larva (105) and fifth-stadium larvae (others).



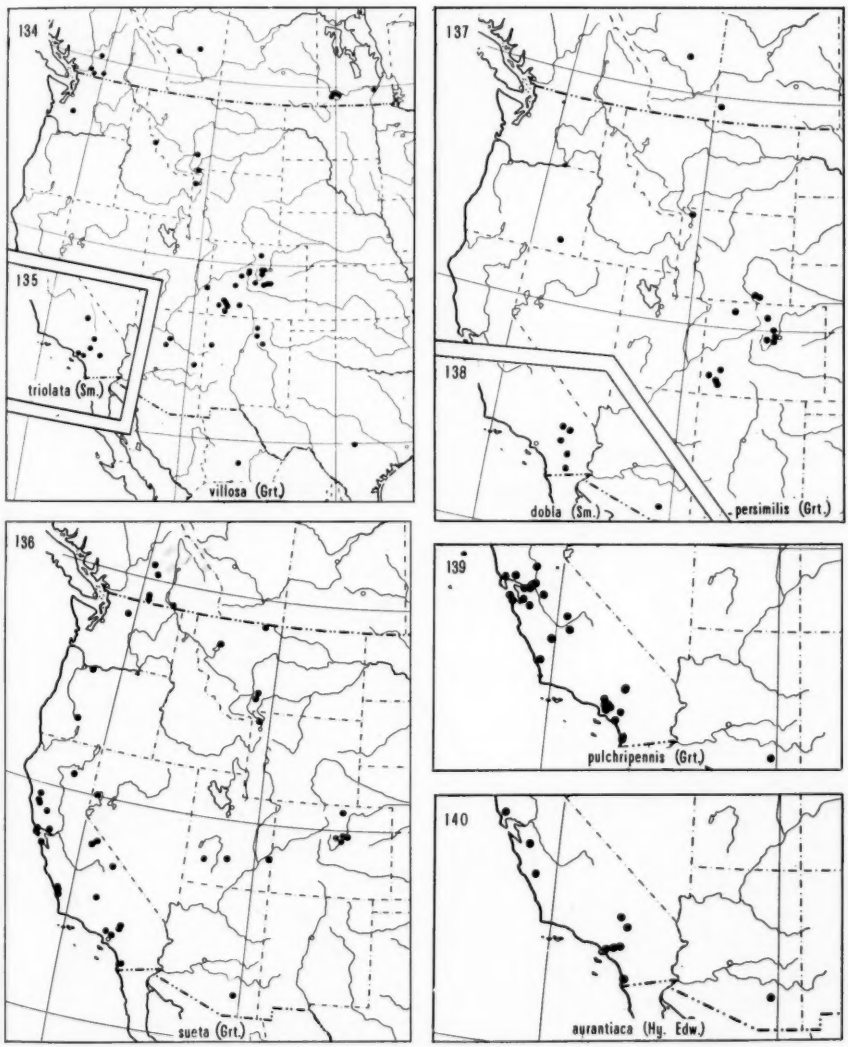
Figs. 108-114. Pupa of *Schinia sueta californica* (Grt.). 108-110, Dorsal, left lateral, and ventral aspects. 111, Right lateral aspect of fourth and fifth abdominal segments. 112, Spiracle on fifth abdominal segment. 113, Ventral aspect of thoracic appendages. 114, Ventral aspect of caudal segments.



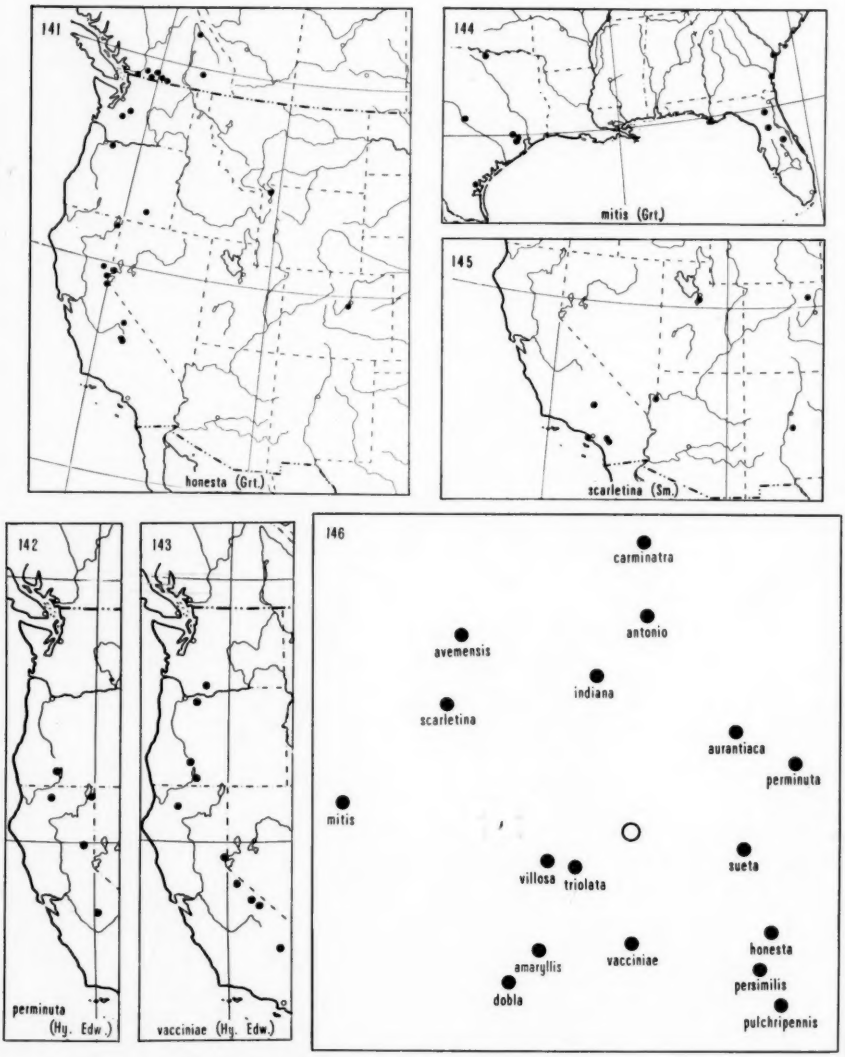
Figs. 115-124. Pupae of *Schinia* spp. 115, 118, 122, Right lateral aspects of fourth and fifth abdominal segments. 116, 119, 123, Ventral aspects of caudal segments. 117, 120, 124, Ventral aspects of thoracic appendages. 121, Spiracle on fifth abdominal segment.



Figs. 125-133. Pupae of *Schinia* spp. 125, 128, 131, Right lateral aspects of fourth and fifth abdominal segments. 126, 129, 132, Ventral aspects of caudal segments. 127, 130, 133, Ventral aspects of thoracic appendages.



Figs. 134-140. Distributions of *Schinia* spp.



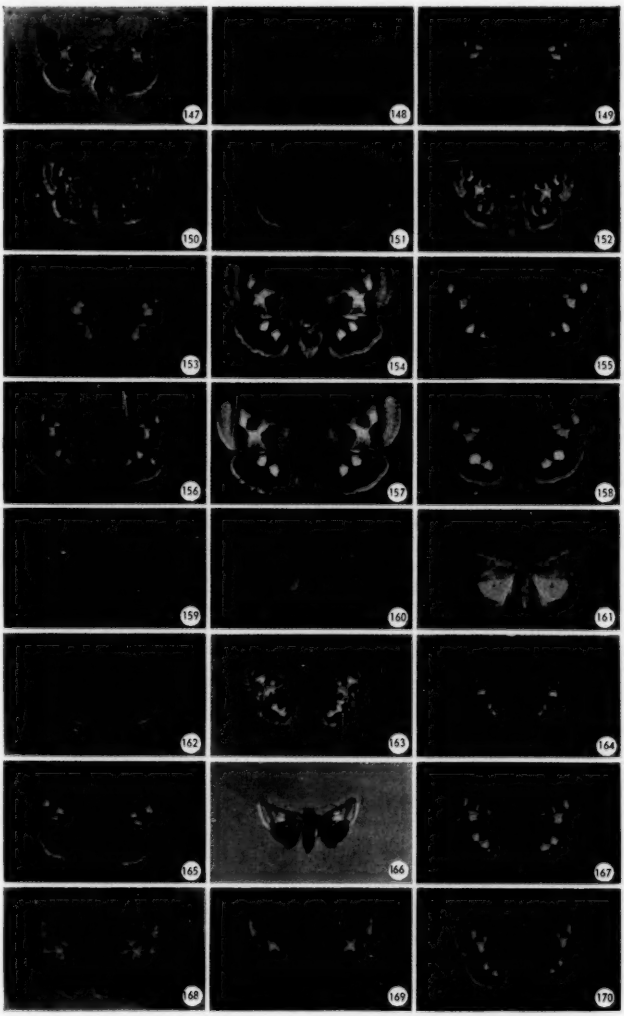
Figs. 141-145. Distributions of *Schinia* spp.

Fig. 146. Suggested relationships among elliptoid-eyed species of *Schinia*, the open circle representing a hypothetical elliptoid-eyed form having all the characters common to all the species considered (see page 20).

COLOUR ILLUSTRATIONS

Figs. 147-170. 147, *Schinia villosa villosa* (Grt.), Gothic, Gunnison Co., Colo. 148, *S. villosa sexata* (Sm.), Aweme, Man. 149, *S. villosa subatra* (Sm.), Blackwall Pk., Manning Park, B.C., 6000 ft. 150, *S. villosa intermontana* Hdwk., Nicola Lake, B.C., 2300 ft. (paratype). 151, *S. villosa conizae* Hdwk., Chihuahua (paratype). 152, *S. triolata* (Sm.), Whitewater, Riverside Co., Calif. 153, *S. vacciniae* (Hy. Edw.), Mt. Hood, Oreg. 154, *S. sueta sueta* (Grt.), Colo. 155, *S. sueta californica* (Grt.), Fairfax, Marin Co., Calif. 156, *S. sueta sierrae* Hdwk., Lassen Pk., Shasta Co., Calif. 157, *S. sueta martini* Hdwk., Osoyoos, B.C., 3500 ft. (paratype). 158, *S. sueta aetheria* (B. and McD.), Redington, Ariz., (paratype). 159, *S. aurantiaca* (Hy. Edw.), San Antonio Valley, Santa Clara Co., Calif. 160, *S. aurantiaca* (Hy. Edw.), Red Mountain, San Bernardino Co., Calif. 161, *S. aurantiaca tenuimargo* (B. and McD.), Redington, Ariz. 162, *S. indiana* (Sm.), Hammond (Hessville), Ind. 163, *S. amaryllis* (Sm.), Calif. 164, *S. perminuta* (Hy. Edw.), Shasta Co., Calif. 165, *S. dobla* (Sm.), Thousand Palms, Riverside Co., Calif. 166, *S. antonio* (Sm.), Pharr, Tex. 167, *S. honesta* (Grt.), Blackwall Pk., Manning Park, B.C., 6000 ft. 168, *S. scarletina* (Sm.), Redondo Beach, L.A. Co., Calif. 169, *S. scarletina* (Sm.), Desert Center, Riverside Co., Calif. 170, *S. persimilis* (Grt.), Cypress Hills, Maple Creek, Sask.

Specimens 158, 161, 163 photographed through the courtesy of the United States National Museum; 166 of Otto Buchholz. Other specimens in the Canadian National Collection.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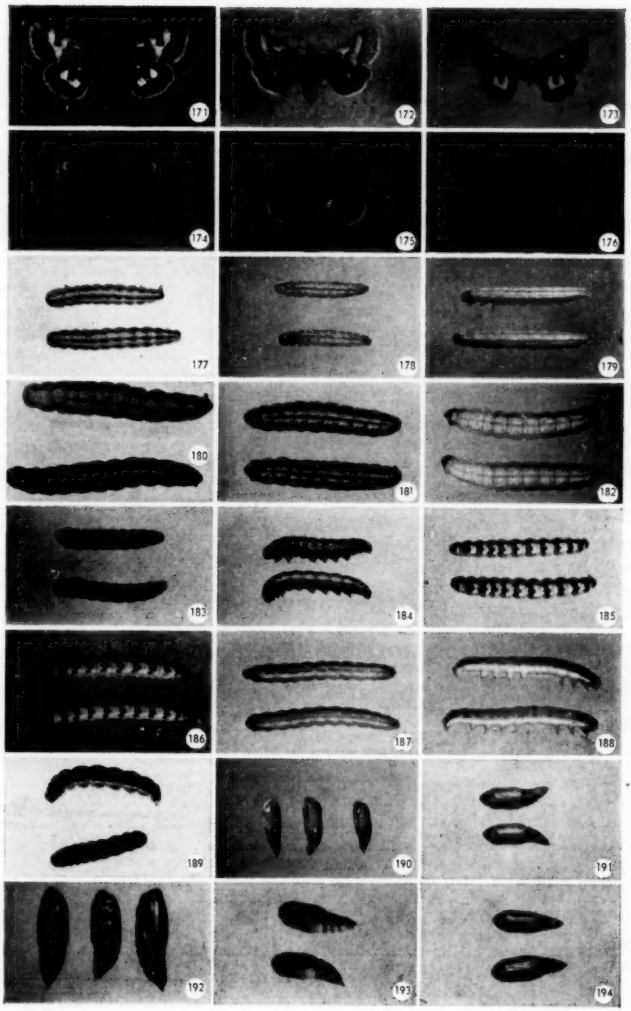
167
168
169
170

Figs. 171-194. 171, *Schinia persimilis* (Grt.), Cypress Hills, Maple Creek, Sask. 172, *S. pulchripennis* (Grt.), Pittsburgh, Contra Costa Co., Calif. 173, *S. scissa* (Grt.). 174, *S. avemensis* (Dyar), Aweme, Man. 175, *S. mitis* (Grt.), Ark. 176, *S. carminatra* (Sm.), Walsenburg, Colo., 6200 ft. 177, *S. villosa subatra* (Sm.), Blackwall Pk., Manning Park, B.C., 6000 ft. 178, *S. villosa intermontana* Hdwk., Twin Lakes, Keremeos, B.C., 2800 ft. 179, *S. triolata* (Sm.), Whitewater, Calif. 180, *S. sueta californica* (Grt.), Marin Co., Calif. 181, 182, *S. sueta martini* Hdwk., Osoyoos, B.C., 1200 ft. 183, 184, *S. indiana* (Sm.), Hammond (Hessville), Ind. 185, 186, *S. dobla* (Sm.), Fish Creek Mts., San Diego Co., Calif. 187, 188, *S. scarletina* (Sm.), Desert Center, Riverside Co., Calif. 189, *S. pulchripennis* (Grt.), Pittsburgh, Contra Costa Co., Calif. 190, *S. villosa intermontana* Hdwk., Nicola Lake, B.C., 2300 ft. 191, *S. triolata* (Sm.), Whitewater, Riverside Co., Calif. 192, *S. sueta martini* Hdwk., Osoyoos, B.C., 1200 ft. 193, *S. indiana* (Sm.), Hammond (Hessville), Ind. 194, *S. dobla* (Sm.), Fish Creek Mts., San Diego Co., Calif.

Specimen 173 photographed through the courtesy of the United States National Museum; 176 of the American Museum of Natural History. Other specimens in the Canadian National Collection.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190
191
192
193
194

INDEX

To genera and lower categories of heliothidines discussed, and to their food plants. All specific and infraspecific names without generic assignment are referable to the genus *Schinia*.

INDEX—*Continued*

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